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MAINTAINABILITY IMPROVEMENT THROUGH CORROSION PREDICTION

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13. ABSTRACT *(Maximum 200 words)*
In 1994, the Scientific Advisory Board (SAB) reported that "Corrosion is the single most costly maintenance problem for USAF aging aircraft." In 1997, the National Materials Advisory Board (NMAB) investigated the aging of USAF aircraft and reported that "corrosion can progress significantly before being observed, leading to increased maintenance costs and time in PDM (Programmed Depot Maintenance)". These concerns are recognized by the USAF in having identified the C/KC-135 aircraft as being life limited by corrosion with respect to life cycle cost sustainment of the fleet (the first fleet identified in this manner). The NAMAB stated in its recommendations for the USAF, the "most important operational needs include...improved understanding of probable rates of corrosion and corrosion trends for specific operational aircraft for use in planning maintenance actions".

The overall objective of this effort was to assess the possibility of developing corrosion damage formation and growth models to assist in prediction corrosion maintenance actions (inspection and repair) on aluminum airframe structure. The assessment involved a review and evaluation of corrosion research and available data for the purpose of identifying or proposing corrosion formation and growth models. The corrosion research and available data considered under this effort included current research efforts directed at airframe corrosion damage formation and growth, USAF corrosion maintenance programs, aircraft basing history information, fleet maintenance data (inspection reports and repair orders), and airbase corrosion severity indices.
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Two model types emerged as possible frame works to predict the location and severity of corrosion occurrences. First, a model based on aircraft historical trends using statistical models of historical corrosion repair records to predict near term corrosion damage trends. Second, a model based on corrosion damage mechanics. This approach models corrosion damage in equivalent material/mechanical property terms. It allows corrosion damage to be inserted into existing structural integrity frameworks for evaluating the effects of corrosion formation and growth.

This report presents an evaluation of the present state-of-the-art for both approaches. Information available to support each approach is identified and its adequacy for supporting USAF fleet management needs is evaluated. Gaps in the existing information are defined, as technology development activities needed to close the gaps.

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List of Acronyms

Acronym	Definition
AFMC	Air Force Material Command
AFMC-202	AFMC form 202, PDM Engineering Disposition Repair Records
AFRL	Air Force Research Laboratory (at WPAFB)
AFRL\ML	Materials Directorate of AFRL
AFRL\VA	Air Vehicles Directorate at AFRL
AIRS	Corrosion and Structural Repair Tracking, AFTO Form 58
ALC	Air Logistics Center
AMC	Air Mobility Command
AMMP	Air Mobility Master Plan
DADTA	Durability and Damage Tolerance Assessment
IATP	Individual Aircraft Tracking Point
MDCS	Maintenance Data Collection Systems
MTBC	Mean Time Between Corrosion
NDE/I	Nondestructive Evaluation/Inspection
OACIS	Over and Above Centralized Information System
OC-ALC	Oklahoma City Air Logistic Center
PDM	Programmed Depot Maintenance
PSE	Principal Structural Element
R&M	Reliability and Maintainability
REMIS	Reliability and Maintainability Information System
TO	Technical Order
USAF	United States Air Force
WFD	Widespread Fatigue Damage
WPAFB	Wright Patterson Air Force Base
WR-ALC	Warner Robins Air Logistics Center

SUMMARY

The R&M and readiness costs of aging aircraft could be better controlled by optimizing (altering) the scheduled inspections and repairs using procedures which include a corrosion prediction model. The model would provide estimates of corrosion formation and growth rates to assist in estimating/scheduling the level and location of corrosion inspection and repair actions. The optimization of inspection intervals and repair actions due to corrosion could also be based on the risk of fracture using the estimated maintenance repair actions and the associated costs for the anticipated corrosion level.

The overall objective of this effort was to assess the possibility of developing a corrosion damage formation and growth model to assist in predicting corrosion maintenance actions (inspection and repair) on aluminum airframe structure. The assessment involved a review and evaluation of corrosion research and available data for the purpose of identifying or proposing corrosion formation and growth models. The corrosion research and available data considered under this effort included current research efforts directed at airframe corrosion damage formation and growth, USAF corrosion maintenance programs, aircraft basing history information, fleet maintenance data (inspection reports and repair orders), and airbase corrosion severity indices.

The approach was to first perform a general assessment to determine if sufficient models and data exist to currently make predictions of corrosion damage formations and growth. Then to identify significant influences in the models such M&P parameters, environment, structural function/location, and relation to actual service usage. Two model types emerged as possible frame works to predict the location and severity of corrosion occurrences. First, a model based on aircraft historical trends uses statistical models of historical corrosion repair records to predict near term corrosion damage trends. Second, a model based on corrosion damage mechanics. This approach models corrosion damage in equivalent material/mechanical property terms. It allows corrosion damage to be inserted into existing structural integrity frameworks for evaluating the effects of corrosion formation and growth. The two

approaches are not mutually exclusive, and each possesses a set of advantages and shortcomings unique to itself.

This report contains an evaluation of the present state-of-the-art for both approaches. Information available to support each approach is identified and its adequacy for supporting USAF fleet management needs is evaluated. Gaps in the existing information are defined, as technology development activities needed to close the gaps. The feasibility of successfully completing the identified technology development activities to obtain usable fleet management tools is also addressed.

The information available for use with the damage mechanics approach consists of the large body of public and known proprietary literature resulting from numerous research activities on the subject of corrosion. This information provides a great deal of insight into corrosion mechanisms for various metallic materials subject to a variety of environmental exposure conditions. It has been successfully used to enhance the inherent corrosion resistance of numerous alloys, and has served as a critical base for development of various treatments or coatings to retard the development of corrosion damage. The principal shortcoming of available corrosion literature lies in the absence of strong, quantitative links between laboratory corrosion protocols and structural service conditions. The relationships between accelerated laboratory corrosion testing and structural service are thus undefined.

A principal impediment to the development of firmer links between accelerated corrosion testing in the laboratory and prediction of corrosion under actual service conditions is the lack of quantitative metrics for corrosion damage. Although corrosion damage occurs in a variety of unique and non-exclusive forms, the metrics used to describe the damage are either highly qualitative (i.e., "light," "moderate," "severe") or so detailed (individual pit dimensions) as to be almost impossible to measure outside the laboratory. A few, very recent, corrosion damage assessment studies have begun to show some promising results. Such as a Boeing (St Louis) study that showed reasonable agreement with test data by using a crack growth analysis with a crack size equal to the average pit depth and density. Quantitative metrics of corrosion damage are an essential (and nearly absent) element of a damage mechanics approach to corrosion in aging Air Force fleets.

A technology development path for creating a damage mechanics approach for corrosion damage assessment is outlined in the body of the report. This path is fairly extensive, and successful completion will require the commitment of significant resources. The prospects of technical success are quite good, however, as many element of the development path parallel those already used for evaluation of mechanical damage such as cracks.

An alternative, although not a mutually exclusive one, to a damage mechanics approach to corrosion is compilation and correlation of service history data, in particular, data dealing with repairs due to airframe corrosion damage. A model based on the prior airframe repairs uses the trends in corrosion repair history to predict the corrosion damage rates for a near term or approaching PDM interval. The data requirements for the corrosion repair records include corrosion records that consistently provide some qualitative level of corrosion damage. Ideally there will also be a link to inspection records where quantitative measures of corrosion damage are recorded. As a minimum, the corrosion damage level will need to be qualified (light, severe, etc) then capable of being grouped by aircraft serial number, airframe location/zone, date of repair, basing history, material type, assembly feature, and other factors shown to influence the trends. Statistical modeling tools will need to be used to represent or model the data trends as a function of time. Then predictions of corrosion damage degrees can be estimated.

SECTION 1 - INTRODUCTION

1.1 Background/Scope

Although it is not addressed in either the design or evaluation of new aircraft, corrosion of aluminum airframe structures has historically been recognized as a damage mechanism that may adversely affect airworthiness. Recognition of the potential dangers of corrosion damage has led to the development and implementation of extensive formalized (albeit largely heuristic) programs to prevent, detect, and remedy the consequences of corrosion damage in aircraft. The efficacy of these programs is evidenced by the fact that loss of an aircraft has never been directly attributed to corrosion damage[1]. This success is at least partially attributable, however, to the fact that many aircraft fleets have in the past been replaced before they reached the age at which extensive corrosion might be expected. It has also been achieved only at significant cost. Commercial and military fleet operators spend billions of dollars annually to prevent, detect, and remedy corrosion damage.

The adequacy of the traditional approach toward dealing with corrosion damage to aircraft is becoming increasingly questioned due to a number of factors. Although it did not result in loss of the aircraft, and, given its potential, caused a minimal loss of life, the "Aloha incident" created a significant and widespread awareness of the potential hazard posed by corrosion damage in airframe structures. Subsequent investigation revealed that a number of factors were actually involved in the structural failure, and that corrosion had not been the sole cause of the incident. The widespread publicity given to the event itself and its aftermath nonetheless elevated corrosion to the role of a serious and real threat to airworthiness.

The effective or imminent withdrawal from service of a number of traditional corrosion prevention compounds (CPC's) has further elevated concern over the potential significance of corrosion damage to aircraft structures. The environmental and health concerns associated with the use of traditional CPC's, the most effective of which are based on chromates, has generated a significant effort to develop

[1] The validity of this statement is strongly questioned in some quarters of the aircraft structural integrity community. They contend that some of the airframe failures attributed to fatigue crack growth should be attributed to corrosion, which is the source of the initial crack, rather than to fatigue, which subsequently grows the crack.

alternatives less dangerous to their users and the public at large. While some success has been achieved, it is generally conceded that the newer CPC's are not yet as effective as those they are meant to replace. The efficacy of corrosion prevention measures must thus be expected to decrease, at least in the immediate future. The prevalence of corrosion damage and the cost of remedying it must be expected to increase accordingly.

The increasing age of military (and commercial) aircraft fleets has also generated significant interest in defining the effects of corrosion damage on airworthiness and projecting those effects as a function of continued aircraft service. The frequency of occurrence, the extent, and the severity of corrosion damage in these aging fleets is generally expected to increase, simply as a function of calendar time. The increasing occurrence of corrosion damage is certain to increase maintenance costs and reduce aircraft availability, thus impacting readiness. The traditional methods of dealing with such damage, however, do not include the predictive capability needed to project the scope of the increased maintenance activities nor the time frame in which they will develop. Plans for extending the service lives of aging aircraft must thus be made without adequate consideration of corrosion damage, despite the central role of such damage to the technical and economic feasibility of those plans.

1.2 Background/Scope

The objective of the study described in this report is to assess the current state of the art in corrosion technology, and the applicability of that technology to the needs of the Air Force. In the short term, those needs are primarily focused on defining the near-term impact of corrosion damage on repair time and costs, and thus on fleet readiness. In the longer term, however, the Air Force will require fleet management tools that incorporate the effects of corrosion damage and can be used to define inspection intervals, PDM cycles, repair costs and time, and airworthiness well into the future. Such a tool is essential to service life extension plans for Air Force fleets, and provides the information necessary to balance such plans with aircraft procurement activities.

SECTION 2 – STATUS OF CORROSION TECHNOLOGY

2.1 Introduction

Existing information on corrosion technology can be roughly grouped into two major categories, one focused on the phenomenon of corrosion as a function of materials and environments, and the other focused on the implications of corrosion to airworthiness. The former category includes the bulk of the published literature on corrosion and corrosion fatigue. The information in the latter category is primarily derived from maintenance and service history data. Each of these categories is examined in turn to define the current state of the art and assess the utility of the existing information for Air Force needs.

2.2 Corrosion Phenomena

2.2.1 State of the Art

A vast amount of effort has been expended on investigating the various aspects of corrosion. Open-literature citations number in the many hundreds, if not thousands. Collections of proprietary information, some commensurate in size with the open-literature resources, have also been compiled by material suppliers, manufacturers, and end-users of a variety of products, such as aircraft structures, civil structures, and power generation equipment. The extensive efforts underlying these collections of information (public and proprietary) have greatly enhanced the understanding of numerous aspects of the corrosion process.

The existing literature on corrosion technology clearly reflects the extraordinary complexity of the topic. Corrosion is an extremely complex phenomenon that depends on numerous factors, including the chemical composition and physical microstructure of the materials being corroded, the chemical composition of the corrosive environments, the frequency and duration of exposure, and both the thermal and loading profiles. It is generally accepted that these factors interact to some degree, but the neither the interactions nor their extent have been well-defined. Most of the data reported in the

literature is thus specific to the particular conditions and materials for which it was obtained. Pooling of data from different studies is difficult at best.

The number of disciplines involved in the study of corrosion compounds the diversity of the literature data. Material scientists, electrochemists, and structural integrity specialists, all of whom approach the topic from their perspective of the specific discipline, have addressed the corrosion phenomena. This breadth of viewpoints is essential to treating the complexities of corrosion. It also tends to diffuse the focus of corrosion studies, however, so that data from one study may be almost unintelligible to corrosion workers of another discipline. The range of perspectives involved further complicates the use of available literature data.

While some work has been done to determine physical characteristics of pitting and exfoliation types of corrosion damage in the laboratory, the applicability of this work to aircraft structures is uncertain. The vast bulk of the existing work on aluminum corrosion has been done with the intent of either ranking different materials or developing an understanding of corrosion phenomena, particularly at the microscale level, rather than with the intent of simulating given service conditions. The corrodents used, such as 3.5% NaCl, Exco, and other test standards, as well as the exposure protocols, are typically selected for experimental convenience, rather than to simulate service environments. The relationship between these corrodents and the damage incurred during aircraft service is not clear. However, it has been noted that very aggressive laboratory standard corrodents, such as Exco, may actually yield damage less severe than that produced by less severe service conditions, because the more aggressive solutions lead to widespread attack, reducing both the depth and acuity of individual pits. Thus, the use of ostensibly "conservative" protocols for accelerated laboratory simulation of corrosion damage may actually lead to results which are not typical, nor even necessarily more severe, than those found in actual service.

A number of efforts have been made to define realistic service environments for aircraft structures and to develop protocols for simulating service-induced aircraft corrosion damage in the laboratory [1-6]. Some success has been achieved in characterizing the corrosive environments present in specific aircraft, but the limited scope of these efforts suggests that any of the results should be generalized only with

caution. Indeed, attempts to replicate initial successes in some of these studies have led to results diametrically opposed to those initially obtained. Until the issues surrounding the full definition and simulation of actual aircraft service environments are resolved, the only reliable basis for assessing corrosion damage in airframes will be from the aircraft themselves.

A substantial amount of work has been conducted on the fatigue and crack growth response of metallic materials following and/or during exposure to a corrosive environment. Most of this work has, however, been done with corrosion protocols chosen for their ability to produce corrosion damage within reasonable periods of time in the laboratory. Little, if any, of the existing work has been done with chemical environments or loading conditions which simulate aircraft service conditions. (Indeed, such conditions are not well characterized.) The applicability of this work for evaluation of airframe structures is thus uncertain. Moreover, the corrosion damage is rarely well characterized. In many instances, the corrosion damage is simply described in terms of the corrosion protocols used, rather than in terms of its physical characteristics. The omission of direct characteristics of the corrosion damage further limits the utility of this work for evaluation of aircraft structures.

The role of corrosion pits as crack initiation sites has been widely recognized, and numerous studies of crack initiation from corrosion pits have been conducted. Many of these efforts have been focused on analysis of an existing corrosion pit as a physical stress concentration, however, and have little to do with the development and growth of the pit. In cases where growth data are provided, their use data is further complicated by the diversity of structural materials, corrosion protocols, and loading conditions represented.

Some attempts have been made to model the initiation and growth of corrosion pits, e.g., [7]. The proposed models, however, require the use of empirically determined parameters specific to the material(s) and environmental conditions of interest. While agreement between model predictions and test data (sometimes the same data used to define model parameters) has been shown, the general applicability of the models has not been demonstrated. While these pitting models may be a suitable basis for predicting the accrual of corrosion damage in airframes after some amount of further

development, the present need to empirically define model parameters for each unique combination of materials and environmental exposure constitutes a significant obstacle to use outside the laboratory.

The efforts devoted to crack initiation at corrosion pits are much more substantial than those devoted to other types of corrosion damage. While some work has been done to define the mechanisms of stress-corrosion cracking, there appears to have been little or no attention paid to the effects of corrosion damage forms such as exfoliation and intergranular attack. Equivalent mechanical damage models for these types of corrosion damage are very much lacking in the literature, as are any data which might be used to begin development of such models.

It must also be recognized that laboratory corrosion studies commonly require accelerated accrual of corrosion damage, relative to its usual pace in actual structures. A number of standardized protocols for rapidly introducing corrosion damage have been developed, and an almost infinite variety of modified or alternative protocols have been used to some degree. These protocols are largely used for comparative ranking of material corrosion resistance, however, and the relationship between these accelerated protocols and actual service conditions is not well established. The marked disparity between the corrosion resistance of coupons of alloy 7079-T6 and the subsequent corrosion performance of the material in airframe service underscores the need for exceptional caution in applying the results of accelerated laboratory corrosion tests to aircraft service conditions. Projection of service experience from laboratory test results must thus be done cautiously.

2.2.2 Applicability to Air Force Needs

Existing information on corrosion phenomena in aluminum has supported and enabled a number of developments of value to the Air Force. Detailed understanding of corrosion kinetics and electrochemistry have supported the development of new aluminum alloys and heat treatments having higher levels of corrosion resistance than their predecessors. Such knowledge has also contributed to the development of improved corrosion protection systems (CPC's) to inhibit or prevent the development of corrosion in aircraft structures. Even aspects of aircraft design and assembly, such as

electrical isolation of dissimilar metals and wet installation of fasteners, have been touched by or founded on detailed understanding of fundamental corrosion phenomena in aluminum alloys.

Current understanding of corrosion phenomena in aluminum alloys and the improvements derived from it are primarily of value in the design and construction of new aircraft. Improved aluminum alloys, product form manufacturing processes, and heat treatments can be implemented on new aircraft during the design stage with relative ease. Similarly, improvements in CPC's and aircraft assembly processes can be readily applied to new aircraft. The Air Force has derived significant benefits from these developments in its new aircraft procurements, and will continue to derive such value in the future.

The significant decline in Air Force procurement levels, coupled with the increasing age of Air Force fleets, has created the need to address airframe corrosion issues in existing aircraft as well as new ones. The traditional benefits of aluminum corrosion technology can, of course, be applied to aircraft in service as well as to those in production. Improved aluminum alloys and manufacturing processes, as well as improved CPC's and assembly processes, can be implemented in existing aircraft, but typically only on a limited basis and with considerable difficulty and expense. Some portion of this difficulty and must be attributed to institutional obstacles rather than technical ones. Replacement of "problem" aerostructural components is invariably approached on a case-by-case basis, requiring complete re-analysis and re-qualification of each component to be replaced. While this practice undoubtedly assures that any limitations imposed by use of the replacement part are fully defined and understood. It also greatly contributes to the cost of developing preferred spares for aircraft structural components.

While replacement of older structural materials with improved products enhances airframe corrosion resistance, the extent of the enhancement is neither well quantified nor readily quantifiable. Thus, while changes are expected to enhance the corrosion resistance of aircraft in service, the extent of the improvement is uncertain. This uncertainty also limits the application of much of the existing technology surrounding corrosion phenomena to aircraft structures for fleet management purposes.

While this technology has provided essential insight into paths for improving the corrosion resistance of aluminum aerostructures, the link between the numerous laboratory studies which have been conducted and aircraft service has not been developed. The laboratory studies have been conducted with a variety of artificial accelerated corrosion protocols designed to produce significant levels of corrosion damage in relatively short periods of time. It is not at all certain that the corrosion damage created with these artificial protocols has the same impact on airworthiness, as does naturally occurring corrosion damage. The similarities and differences between damage created with these artificial protocols and actual aircraft service have not been assessed to any significant degree, and, indeed, actual aircraft service conditions, as they relate to the accrual of corrosion damage, have not been thoroughly investigated or defined. There is thus little in the existing technology base for corrosion phenomena that can be used to either assess airworthiness or to project changes in airworthiness with future aircraft service.

2.3 Service History Data

2.3.1 State of the Art

Use and maintenance of Air Force aircraft is a highly formalized process, attended by detailed record keeping. These records constitute, at least in theory, a basis for defining the prior history of a given aircraft, including maintenance activities required to remedy corrosion damage. These histories could be used to define relationships between aircraft service and age and the occurrence of corrosion damage. For sufficiently old aircraft, or those exposed to sufficiently severe usage and/or basing environments, it would also be possible to establish correlation between the service/age of the aircraft and the frequency and extent of corrosion damage repairs. Extrapolation of such data could provide some indication of future maintenance requirements, and thus a forewarning of the end of useful economic life for a given aircraft.

Past attempts to compile and evaluate service history data have met with indifferent success [8]. Tracking of individual aircraft is complicated by security

considerations, and location of maintenance records often proves a formidable task in its own right. Many maintenance records, moreover, do not exhibit a level of detail sufficient to fully define the location(s) and extent of corrosion damage. Levels of corrosion damage, in particular, are often defined in rather imprecise terms. Maintenance data also vary according to the emphasis placed on maintenance by local commanders, which can differ significantly from base to base and from aircraft type to aircraft type. While these issues are being remedied as a result of the growing emphasis on corrosion damage in Air Force fleets, the historical data base is neither easy to use nor entirely reliable as a source of information on the progression of aerostructural corrosion.

Destructive tear down of individual aircraft has also been used to obtain direct information concerning the state of corrosion damage to aging aircraft structures [9]. This approach can yield vast amounts of information, and eliminates much of the uncertainty and lack of precision that is encountered in service history records. It is also, however, quite expensive and time-consuming. The scope of the undertaking and the fact that the subject aircraft is effectively destroyed in the process limit the use of tear-downs as a tool for evaluating airframe corrosion damage. Thus, while extensive amounts of information are obtained by aircraft tear-downs, the process provides little information on the fleet-wide status of corrosion damage. Since the tear-down process is most likely to be applied to aircraft that are already unserviceable, however, the results obtained should not be taken to be typical of other aircraft in the fleet.

One significant benefit of aircraft tear-down efforts has been the generation of archive material for testing and evaluation. This material contains naturally induced corrosion damage, and is thus free of the issues surrounding material containing corrosion induced by laboratory corrosion simulation protocols. It is, in fact, the only suitable basis for developing laboratory corrosion simulation protocols that will simulate naturally occurring corrosion damage. Such material has, however, an additional quality. It is of the same pedigree as at least most of the material on aging Air Force aircraft. This attribute is significant because ongoing improvements in material processing have resulted over time in performance improvements in nominally unchanged material, i.e., material meeting a given composition specification. The

impact of the gradual improvements on resistance to corrosion damage and its airworthiness implications has not been systematically evaluated. However, it is probable that the corrosion resistance and/or damage tolerance of current generation materials, corroded and uncorroded, is somewhat higher than that of their nominally identical predecessors, made a decade or two ago.

2.3.2 Applicability to Air Force Needs

In contrast to corrosion technology *per se*, service history data are of limited use for the design and construction of new aircraft. Service history data has been and is of significant value to the Air Force in terms of maintaining and upgrading its existing fleets of aircraft, however. A number of "problem parts" have been identified, and various upgrade programs to replace these parts with improved versions have been initiated. Such efforts have reduced maintenance costs and frequency, and some of the lessons learned have been fed back into the design and construction of new aircraft systems.

Forward extrapolation of service history data for fleet management purposes is necessarily uncertain. If past performance were a wholly reliable indication of future performance, the aging aircraft issue would not exist, since aircraft that had maintained their performance in the past would be expected to do so in the future. Extrapolation is further hampered by the inconsistent quality and detail of the existing service history data. It must also be recognized that most service history data are based on maintenance activities, during which the corrosion state of the aircraft is altered by repair. Thus, the continuing accrual of corrosion damage in the aircraft is periodically reversed to some degree. Although this effect must be incorporated into any forward extrapolation of service history data, the path for doing so is not well defined.

Tear-down activities have provided an essential stock of archive material, corroded and uncorroded, for further evaluations of corrosion damage and its potential effects on airworthiness. Tear-down efforts have also been a principal enabler for some initial efforts to develop more accurate and quantitative metrics for corrosion damage than have been used in the past. Limited testing of archive material has formed an initial basis for developing the linkages between corrosion damage and its

implications to airworthiness. Aircraft tear-downs do, however, provide only a snapshot in time. The absence of history information, in combination with the limited number of tear-downs which can be carried out, limits the value of tear-down results for the purposes of projecting the future corrosion performance of aircraft fleets.

2.4 Summary

Enormous strides have been made in understanding the mechanisms and processes of corrosion phenomena in aluminum alloys. This fundamental understanding has yielded significant benefits to the Air Force in terms of improved alloys and processes which provide materials with corrosion resistance far superior to that of older materials. It has also enabled the development of improved CPC's and assembly processes which enhance the corrosion resistance of an airframe. Its applicability to fleet management issues, in particular the projection of corrosion damage accrual as a function of continued aircraft service, is not clear, however, nor is the path by which the existing fundamental knowledge could be applied to actual aircraft.

Historical service data provides a possible alternative to more sophisticated technology for defining the development of corrosion damage as a function of aircraft service. The level of detail contained in historical records is often inadequate to yield a clear picture of damage accumulation, however. Moreover, the primary source of historical data is inspection and maintenance records. Since detectable corrosion damage is invariably repaired, either by removal or replacement of the damaged structure, the corrosion state of the aircraft is altered. Thus, the historical records provide some insight into the early stages of corrosion damage accrual, but have little or no information concerning its later stages, which are of primary interest to management of aging aircraft fleets. The ongoing revision of the corrosion state of the aircraft also poses a significant obstacle to evaluation of the available information, even with sophisticated statistical techniques.

Despite significant efforts and accomplishments, existing corrosion technology and service data are not adequate for the issues associated with managing the Air Force's aging aircraft fleets. Linkages between available corrosion technology and

aircraft service do not exist, nor does the information about aircraft service conditions needed to create such linkages. Thus, the available corrosion technology cannot be used to quantitatively establish either the impact of corrosion damage on airworthiness nor to project the development of corrosion damage as a function of continued aircraft service. Available service history data lack adequate detail for projection of corrosion damage accrual, and are further tainted by the ongoing (albeit necessary) repair or replacement of corrosion damaged components. A concerted, coordinated, and highly focused effort is needed to establish the technical base required to address the fleet management issues associated with corrosion in aging Air force aircraft fleets.

SECTION 3 – TECHNICAL OPTIONS

3.1 Damage Mechanics

A damage mechanics approach to corrosion has been proposed as a means to remedy some of the shortcomings associated with the traditional prevention/repair method of dealing with corrosion damage in aircraft structures. This approach is based on the modeling of corrosion damage in equivalent mechanical terms, allowing corrosion damage to be inserted into the existing framework for evaluating the effects of cracks and other types of mechanical damage on airworthiness. The method would allow the effects of corrosion damage to be quantitatively evaluated and projected as a function of continued aircraft service or age, exactly as cracks are currently treated.

Much of the infrastructure for a damage mechanics methodology for assessing the impact of airframe corrosion damage is already in place, in the form of the Air Force ASIP program developed to deal with mechanical forms of damage and their impact on airworthiness. Implementation of this methodology will, however, require the development of tool sets and data for two major tasks, modeling corrosion damage in equivalent mechanical terms and projecting the accrual of corrosion damage forward in time.

The first tool needed for modeling corrosion damage in equivalent mechanical damage terms is quantitative metrics of the actual corrosion damage. Corrosion damage occurs in a variety of non-exclusive forms, including gross loss of material over a large region, localized pitting, and intergranular attack. These different physical forms of corrosion damage will have different effects on the mechanical behavior of the host material and are likely to require different mechanical damage models. Current aircraft inspection practice, however, is to qualitatively classify visually detected corrosion damage as light, moderate, or heavy. Such practices not only fail to distinguish among the various modes of corrosion damage, but also fail to provide accurate assessments of the severity of the damage. Moreover, the qualitative measures being used are subject to variability according to aircraft type, inspection facility, and even individual inspector. These qualitative measures of corrosion damage are clearly an inadequate basis for modeling.

A variety of non-visual detection methods for detection of corrosion damage are available or under active development. These non-destructive inspection methods promise more quantitative assessment of corrosion damage, but such methods are largely limited to gross losses of material. Localized pitting and intergranular attack remain relatively immune from detection by any of the non-visual non-destructive examination techniques now available or under development.

Modeling of corrosion damage will require that quantitative metrics for the various types of damage be defined. These metrics must be capable of meeting a range of needs, from field inspection to laboratory research of corrosion processes. It is critical that they be compatible with inspection methods suitable for actual use on aircraft in real shop environments, and that they characterize the physical attributes of the various types of corrosion damage.

Multiple sets of metrics may be needed to satisfy the requirements of inspection and modeling. It is entirely conceivable that metrics suited to available inspection methods will differ from those needed for damage modeling. (Such is, in fact, currently the case.) It may thus be necessary to develop multiple sets of corrosion metrics and the correlations among them.

In order to project the accrual of corrosion damage as a function of future aircraft service, it is necessary to define environmental spectra for specific aircraft or fleets. Because corrosion develops as a function of exposure time rather than operational service, these spectra must be defined in terms of time rather than usage. The specific environmental factors that must be represented in the spectra are fairly well established. Moisture is the essential enabler for corrosion processes, so actual moisture levels must be defined and represented in the environmental spectra. The presence and concentrations of specific chemical species that produce corrosion in aluminum, such as chlorides, sulfates, and nitrates, must also be determined and entered into the environmental spectra. Some efforts to define these factors as functions of basing location have already been carried out under Air Force auspices [10,11]

It is unlikely that global measures of moisture and deleterious chemical species will provide a fully adequate picture of the corrosive environment(s) to which an aircraft

is exposed. Local features, such as seams, fastener holes and tanks, can trap moisture and retain it far longer than it will exist in more exposed areas. Concentrations of corrosive chemical species within these areas may also be significantly different from those found in the general environment. Local, as well as global, measures of pertinent environmental conditions are likely to be needed for accurate projection of corrosion damage accrual.

The time-dependent nature of corrosion damage makes basing location(s) a key element of the environmental spectrum for a given aircraft. It must be recognized, however, that many Air Force aircraft travel extensive distances as part of their normal operation, and are thus exposed to a variety of environments. It is likely that accurate projections of corrosion damage accrual will require environmental spectra that reflect the full range of environmental conditions to which the aircraft is exposed, not just it base location(s) and duration(s).

Characterization of corrosion damage *per se* does not provide information that can be directly input into existing damage mechanics models. Such models are applicable to mechanical damage sites, such as cracks or microstructural defects. In order to apply the established damage mechanics infrastructure and protocols to corrosion damage, it is necessary to convert the metrics of corrosion damage to equivalent forms of mechanical damage.

More than one type of mechanical damage model will probably be required to represent the different types of corrosion damage which may be present in aircraft structure. Highly localized corrosion damage, such as pits, might be modeled as cracks, open pores, or as actual pits. More widespread corrosion damage, such as exfoliation, might be represented as a reduction in section or a wide, shallow pit, depending on the dimensions of the actual damaged region and its physical consequences. Appropriate mechanical models for some types of corrosion damage, such as intergranular attack, are not yet well defined.

The key to defining the transforms between physical metrics of corrosion damage and the corresponding mechanical damage models lies in their requisite equivalence. The basic premise of a damage mechanics methodology for aircraft corrosion is that the presence of corrosion will degrade the mechanical behavior of the

host material to a degree dependent on the severity of the corrosion damage. The transforms between corrosion and mechanical damage may thus be determined by characterizing corrosion damage in a series of test specimens. Testing these specimens to establish the extent of performance degradation. Then, defining the (hypothetical) distribution of mechanical damage (i.e. microstructural cracks) via back calculation would produce the same degradation in performance. Repetition of this process, accompanied by *post mortem* examination of the failed specimens to define the sites of failure initiation, will provide a correlation between the physically based measures of corrosion damage and the corresponding distributions of analytically tractable mechanical damage. This process has already been demonstrated with other types of damage [12,13, and 14]. These two approaches will then yield identical degradation of material performance.

3.2 Service History Data

Although available service history data are plagued by a number of shortcomings, extrapolation of such data offers the most immediate means of gaining some insight into the potential impact of corrosion on aging aircraft fleets. Efforts to compile and categorize available service history data in readily usable formats are already being pursued under Air Force sponsorship. The resulting database(s) offer the possibility of obtaining a more accurate assessment of the state of available service history data than has been heretofore feasible. Rigorous statistical evaluation of the information would be a vital first step in determining the value of further use or collection of service history data.

3.2.1 Service History Database Reviews

The intent of this section is to illustrate the quantity and quality of available corrosion damage data that exists in selected USAF maintenance data collections systems (MDCS). The databases investigated under this effort were assembled and reviewed in collaboration with another USAF funded effort. Reference [15] documents the details of the data gathering and database assembling efforts. Recall that the databases investigated for this effort were generally developed for reasons other than

tracking corrosion damage trends. Therefore, the approach taken here was to first query the databases to identify some relevant details and features of each database. The intent is to identify specific items such as corrosion damage type/geometry characteristics, aircraft basing history, rates of corrosion, and frequencies of repairs for a given component. Then, the data was cross-referenced (cross-tabbed) to identify significant groupings of data. The quality and quantity of the data recorded and archived from corrosion repair records is illustrated by developing Pareto trends (ranking) of the data grouped by selected database field.

The first USAF MDCS to be reviewed was the Reliability and Maintainability Information System (REMIS) which primarily archives data from field level repairs for corrosion. The USAF fleet selected for review was the C-130. Table 1 identifies the database field names, the number of aircraft represented, and the number of records available in the C-130 REMIS database. Table 2 provides the REMIS field name definitions. Note that REMIS does not include any quantification or qualification of the corrosion damage repaired. The location of the corrosion damage can be ascertained from the Work Unit Code (WUC) included in REMIS. The WUC is a specific set of maintenance or repair work instruction for a specific set parts. Therefore a location and a list of effected part numbers can be obtained. Table 3 lists the names of the queries included in the C-130 REMIS MS Access database. These queries were constructed and executed in order to investigate and illustrate the quality and quantity of the data available in the C-130 REMIS database.

The first group of C-130 REMIS queries is intended to identify some general trends in the data concerning corrosion. First, Figure 1 shows the results from a query of the C-130 REMIS database performed to count records grouped by aircraft serial number. These results graphically illustrate the number of individual aircraft and the number of corrosion repairs recorded for each aircraft. Note that on the average, there are only 6.5 repair records for each aircraft serial number in the database. The results from this query can also identify specific aircraft (by serial number) or groups of aircraft that have higher than average record counts. This could infer some aircraft are more susceptible to corrosion damage (due to for example the selected material) or have a more severe corrosion exposure spectrum.

Next, Table 4 shows the results from a query of the REMIS database performed to count repair records grouped by the Geographic Location Code (GeoLoc). These results illustrate the number of aircraft repaired for corrosion at specific geographic locations. The USAF uses these trends to allocate corrosion repair funds to individual field repair stations. Note that the average number of repair records archived in REMIS for each GeoLoc Code is about 60 and that there are only 4 locations with record count values greater than twice the average. Table 5 shows the results from a query similar to that shown in Table 4, but the results are further limited to only those Work Unit Codes (WUC) that have an associated DADTA structure (a principal structural element where a durability and damage tolerance assessment was required). The results indicate that corrosion occurs much less often on critical (flight safety) structure than it does on general airframe structural elements (only 6% of the total REMIS records describe corrosion on DADTA points). This supports the often-stated concept that corrosion, at this time, is a maintenance/readiness issue and not a flight safety concern.

Figure 2 displays the results from a query of the REMIS database that counted records grouped by the aircraft serial number cross-tabbed with the top 4 geographic location codes identified above. These results support the idea that a group of aircraft (serial numbers 880000xxxx through 910000xxxx) is exposed to a more severe corrosive environment. Efforts are thus warranted `to understand/define this environment and to investigate the airframe response to these environmental exposures.

Table 6 shows the query results that counted REMIS records for the C-130 grouped by WUC and the sum of corrosion occurrences. This shows that one WUC accounts for 20% of all the corrosion occurrences recorded in REMIS for the C-130 fleet. That location should further defined to understand the causes of this corrosion rate. Finally for the REMIS database, Figure 3 presents the query results that counted records and averaged the Mean Time Between Corrosion occurrence (MTBC) values grouped by the associated DADTA point linked to the WUC. This figure identifies those DADTA points experiencing a relatively low number of flight hours between corrosion repair actions. These are the points that should be further evaluated for corrosion

resistances. Note that the three DADTA points with the lowest MTBC averages are on the center wing.

The other USAF MDCS to be reviewed was the Over & Above Centralized Information System (OACIS) which archives data from the Programmed Depot Maintenance (PDM) repair records for damage (not just corrosion damage). Note that OACIS only archives data from repair records that are "Over & Above" the repair limits authorized in the repair contract (not necessarily a damage level). The USAF fleet selected for review with OACIS data was the C/KC-135 which has its primary PDM facility at Oklahoma City (OC-ALC). Table 7 identifies the database field names, the number of aircraft represented, and the number of records available in the KC-135 OACIS database. Table 8 provides the OACIS field name definitions. Note that OACIS does not include any quantification (geometry's) of the damage repaired. However, OACIS does include a qualification of the corrosion damage (severe or moderate) in the How Malfunction Code (How Mal). Also, a field that can record the description of the discrepancy is included. Extracting details of the corrosion damage (if recorded) will then require a manual review effort. The location of the corrosion damage can be directly obtained from the Work Area and Zone Codes (W/A and W/Z) recorded in OACIS. Table 9 lists the names of the queries included in the KC-135 OACIS MS Access database. These queries were constructed and executed in order to investigate and illustrate the quality and quantity of the data available in the KC-135 OACIS database.

The first group of KC-135 OACIS queries is again intended to identify some general trends in the data concerning corrosion. First, Figure 4 shows the results from a query of the KC-135 OACIS database performed to count records grouped by aircraft serial number while limited to only those How Mal Codes identifying corrosion (severe and moderate) and cracking. Cracking was included to illustrate the ratio of corrosion damage to cracking damage (that which is usually tracked for DADTA purposes). Note that cracking damage accounts for only 6.7% of all the corrosion and cracking damage records.

Next, Figure 5 summarizes the results of a query that counted records grouped by aircraft tail number and cross-tabbed by the year the repair was completed (and

limited to only corrosion and cracking damage). This figure (using a log scale) shows the total number of corrosion and cracking repair records against the average number of records per aircraft for a given year. Table 10 shows all the details provided by this same query. The intent of this query is to illustrate the capability of the database to support development of historical trends based on the repair records. Highlighted in Table 10 are those aircraft that have been through the PDM maintenance/repair cycle more that once in the period of time that repair records were archived. For example, Tail number 56-3609 has corrosion repair records in 1991 and 1996 which also illustrates the typical 5 year period between PDM cycles. Now a manual review of the corrosion repair records for these identified aircraft is needed to establish if a corrosion trend can be identified. Table 11 and Table 12 provide all the corrosion repair data for aircraft tail numbers 62-3578 and 57-1473 respectively. As can be establish by reading the WUCs, W/As, W/Zs and the discrepancy descriptions, there is no trend indicated. The structural elements repaired in the first indicated year are not listed again in the second indicated year. From a maintenance, readiness, and safety point of view, this is good. That is, the same airframe structural elements are not corroding over a five year period. The degradation due to corrosion is likely occurring over a much longer period of time than 5 years.

3.2.2 Service History Data Summary

Use of service history data as a tool for fleet management will certainly require that collection, categorization, and compilations of past information continue. It will also require that current service history information be collected and placed in whatever databases are being used for the historical information. Significant improvements in the quality and level of detail of the currently generated information will be needed. Sites of corrosion damage need to be identified in very specific detail. The nature, degree, and extent of corrosion damage at each site also need to be recorded in detail, and in as quantitative a manner as possible. Current efforts to facilitate data collection and recording are a step in this direction, but it seems likely that even greater amounts of detail will be needed to allow meaningful extrapolation of service history data.

Meaningful use of service history data will also require detailed information concerning aircraft basing and operating environments. As in the case of a damage mechanics model, characterization of both global and local environments is likely to prove necessary. However, the level of detail needed to characterize environmental exposure for the purposes of extrapolating service history data is probably less than that needed for application of a damage mechanics model.

Because of the inherent variability of service history data, coupled with the variable levels of quality and detail in existing data, forward extrapolation of such data for fleet management purposes is virtually certain to require the application of statistical tools. These tools will have to be relatively sophisticated and robust, in order to extract meaningful trends from the available data. They must also be capable of dealing with the effects of such complicating factors as intermittent repairs, and integrating the consequent change in the corrosion status of the aircraft into projections of future fleet performance. Such tools may heave to be developed and integrated into protocols for utilizing the service history data now being collected and catalogued.

Statistical projections *per se* will not be a suitable basis for estimating remaining fleet lives. Formalized procedures for interpreting such projections, conceptually akin to the Aircraft Structural Integrity Program, will also have to be developed to assure that fleet life estimates have suitable levels of certainty and adequate margins of safety. Such procedures are as essential to the use of service history data as they are currently undeveloped.

Table 1. List of Data Available in the C-130 REMIS Database.

Database File Name:	**C130REMIS.mdb**	**C130REMIS.mdb**
Table Name:	GeoLoc Codes	REMIS
Number of Records:	46	2922
Number of Aircraft	447	447
Date Range		NA
Column Names:	GeoLoc ID	Record
	GeoLoc Code	MDS
	Location Name	GEOGRAPHIC LOCATION
	State or Country	A/C SERIAL NUMBER
		WORK UNIT CODE
		CORROSION OCCURENCES
		REPAIR MANHOURS
		MTBC

Table 2. List of REMIS Database Field Definitions.

Field	**Descriptions**
REMIS_ID	Unique numeric identifier assigned by Access
MDS	Aircraft model on which the damage was discovered.
Geographic Location	Code indicating location of the aircraft when damage was discovered. (Geographic location codes used in the REMIS.MDB database are explained in the GeoLoc Codes table.)
A/C Serial Number	USAF tail number of the damaged aircraft.
Work Unit Code	Work Unit Code applicable to the damaged component. (All MDS work unit codes are described in TO 1C-xxxx-06.
Corrosion Occurrences	Number of times corrosion has been discovered on the component.
Repair Man-hours	Average number of man-hours required to repair the corrosion damage.
MTBC	Mean Time Between Corrosion incidents on the damaged component.

Table 3. List of Queries Included in the C-130 REMIS Access Database (C130REMIS.mdb).

Name of Queries in C130REMIS.mdb
C130 REMIS, GeoLoc, Count Records
C130 REMIS, GeoLoc, MDS, Count Records
C130 REMIS, Records w/DADTA, GeoLoc, Count Records
C130 REMIS, Records w/DADTA, GeoLoc, MDS, Count Records
C130 REMIS, Records w/DADTA, SER#, GeoLoc, MDS, Count Records
C130 REMIS, SER#, GeoLoc, Count Records
C130 REMIS, SER#, GeoLoc, Count Records x
C130 REMIS, SER#, GeoLoc, MDS, Count Records
C130 REMIS, SER#, Top 6 GeoLoc, Count Records
C130 REMIS, WUC w/DADTA, Sum Corr Occurrences, Count Records
C130 REMIS, WUC, Sum Corr Occurrences, Count Records

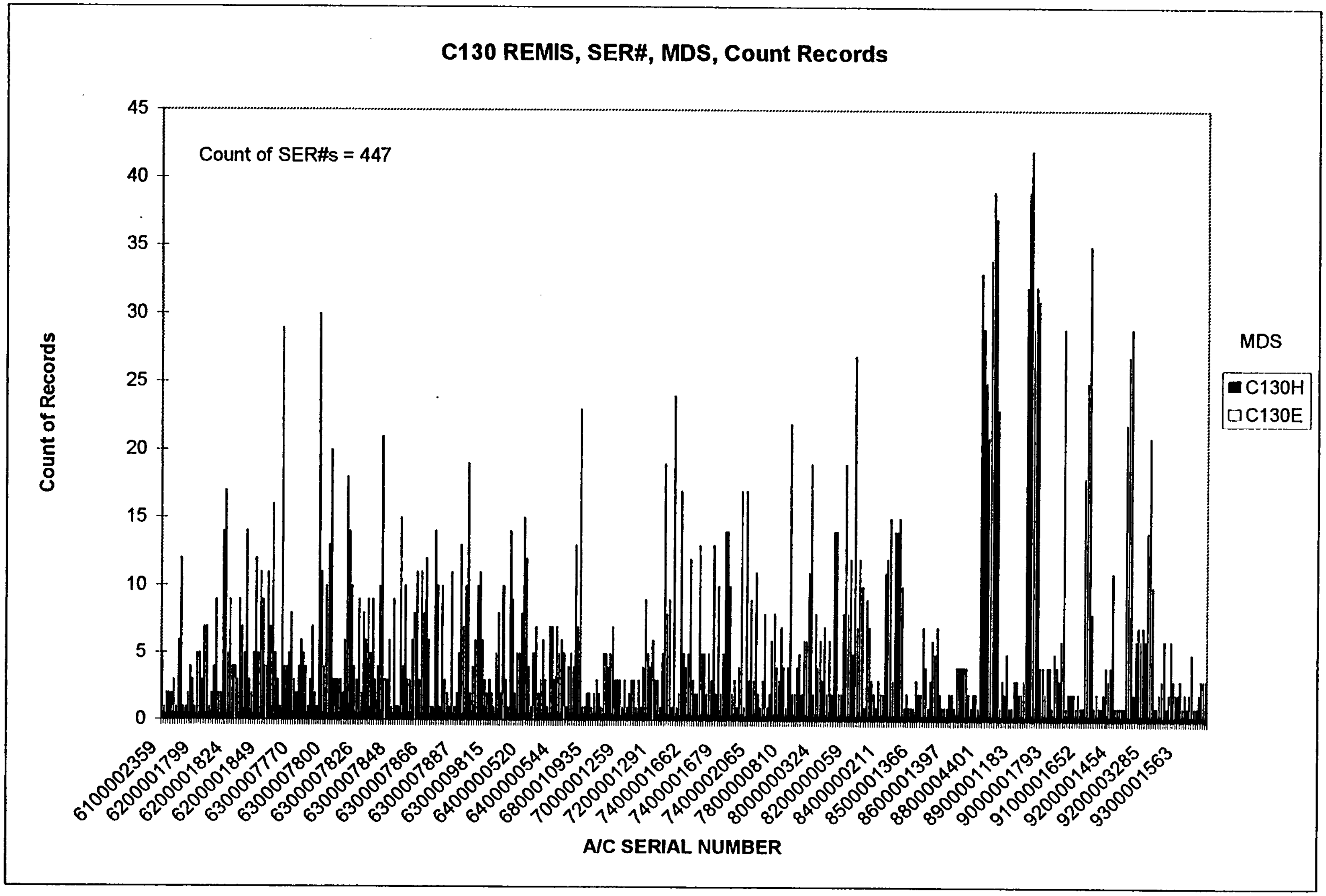

Figure 1. C-130 REMIS, Count Records Grouped by Aircraft Serial Number and Model Design Series (MDS).

Table 4. C-130 REMIS, Count Records Grouped by Geographic Location Code (GeoLoc) and Model Design Series (MDS).

C130 REMIS, GeoLoc, MDS, Count Records					
Sum			1253	1669	2922
Average			52.208	53.839	59.633
			MDS		
			Count of Records		
GEOGRAPHIC LOCATION	Location Name	State or Country	C130E	C130H	Sum
NKAK	Little Rock	AR	435	11	446
ZQEL	Youngstown Municipal Airport	OH		395	395
HTUX	General Billy Mitchell Field	WI		241	241
ZNRE	Yokota	Japan	68	156	224
FNWZ	Dyess AFB	TX		117	117
MAHG	Keesler AFB	MS	116		116
PNQS	Maxwell AFB	AL		94	94
QJKL	Minneapolis-St. Paul	MN	82		82
MLRV	Kulis ANGB	AK		78	78
RVKQ	Niagra Falls	NY		77	77
PJMS	Martin State	MD	74		74
TMKH	Pope AFB	NC	64		64
FGWB	Dobbins AFB	GA		63	63
TYFR	Ramstein AB	Germany	60		60
VBDZ	Schenectady	NY		56	56
ZAWA	Willow Grove	PA	56		56
XDQU	Savannah International	GA		48	48
FJRP	Douglas			47	47
TWLR	Quonset Point	RI	42		42
TDKA	Peterson AFB	CO	17	22	39
QJKD	Minneapolis-St. Paul, ANG	MN	38		38
FTEP	Eglin AFB	FL	30	4	34
NKAT	Little Rock ANGB	AR	34		34
JLSS	Greater Pittsburg International	PA		31	31
DJCF	Channel Islands	CA	29		29
YZEU	Will Rogers World Airport	OK		29	29
DPNB	Chicago-Ohare	IL		27	27
JLQN	Greater Peoria	IL	27		27
PBXP	Mansfield	OH		27	27
JLWS	Greater Wilmington (Newcastle County)	DE		24	24
KHYR	PEMCO Aeroflex	GA		21	21
BKTZ	Nashville Metro	TN		20	20
FXSB	Elmendorf AFB	AK		19	19
LXEZ	Kadena AB	Japan	19		19
VGLZ	Selfridge AFB	MI	17		17
SXHT	Patrick AFB	FL	16		16
EZTH	Dallas	TX		12	12
KNMG	Hickam AFB	HI		12	12
ULYB	Rosencrans Memorial	MO	1	11	12
WEAS	Standiford	KY		12	12
PJVY	Martinsburg	WV	10	1	11
QSEU	Moody AFB	GA	10		10
LYBH	Yeager ANGB	WV		6	6
QFQE	RAF Mildenhall	England	6		6
DPEZ	Cheyenne Municipal Airport	WY		5	5
SHYQ	Olmsted Field	PA		2	2
TQKD			1		1
YKHT			1		1
YWHG				1	1

Table 5. C-130 REMIS, Count Records with DADTA Points Grouped by Geographic Location Code (GeoLoc) and Model Design Series (MDS).

C130 REMIS, Records w/DADTA, GeoLoc, MDS, Count Records

	Sum	91	85	176
	Average	6.5	7.0833	7.04
		MDS		
		Count of Records		
GEOGRAPHIC LOCATION	**Location Name**	**C130E**	**C130H**	**Sum**
MAHG	Keesler AFB	29		29
PNQS	Maxwell AFB		21	21
LXEZ	Kadena AB	18		18
MLRV	Kulis ANGB		13	13
NKAK	Little Rock	11		11
ZNRE	Yokota	1	9	10
FGWB	Dobbins AFB		8	8
HTUX	General Billy Mitchell Field		7	7
FNWZ	Dyess AFB		6	6
FTEP	Eglin AFB	5		5
QJKD	Minneapolis-St. Paul, ANG	5		5
QJKL	Minneapolis-St. Paul	5		5
SXHT	Patrick AFB	5		5
WEAS	Standiford		5	5
YZEU	Will Rogers World Airport		4	4
ZAWA	Willow Grove	4		4
ZQEL	Youngstown Municipal Airport		4	4
KNMG	Hickam AFB		3	3
RVKQ	Niagra Falls		3	3
BKTZ	Nashville Metro		2	2
PJMS	Martin State	2		2
TMKH	Pope AFB	2		2
TYFR	Ramstein AB	2		2
DJCF	Channel Islands	1		1
TWLR	Quonset Point	1		1

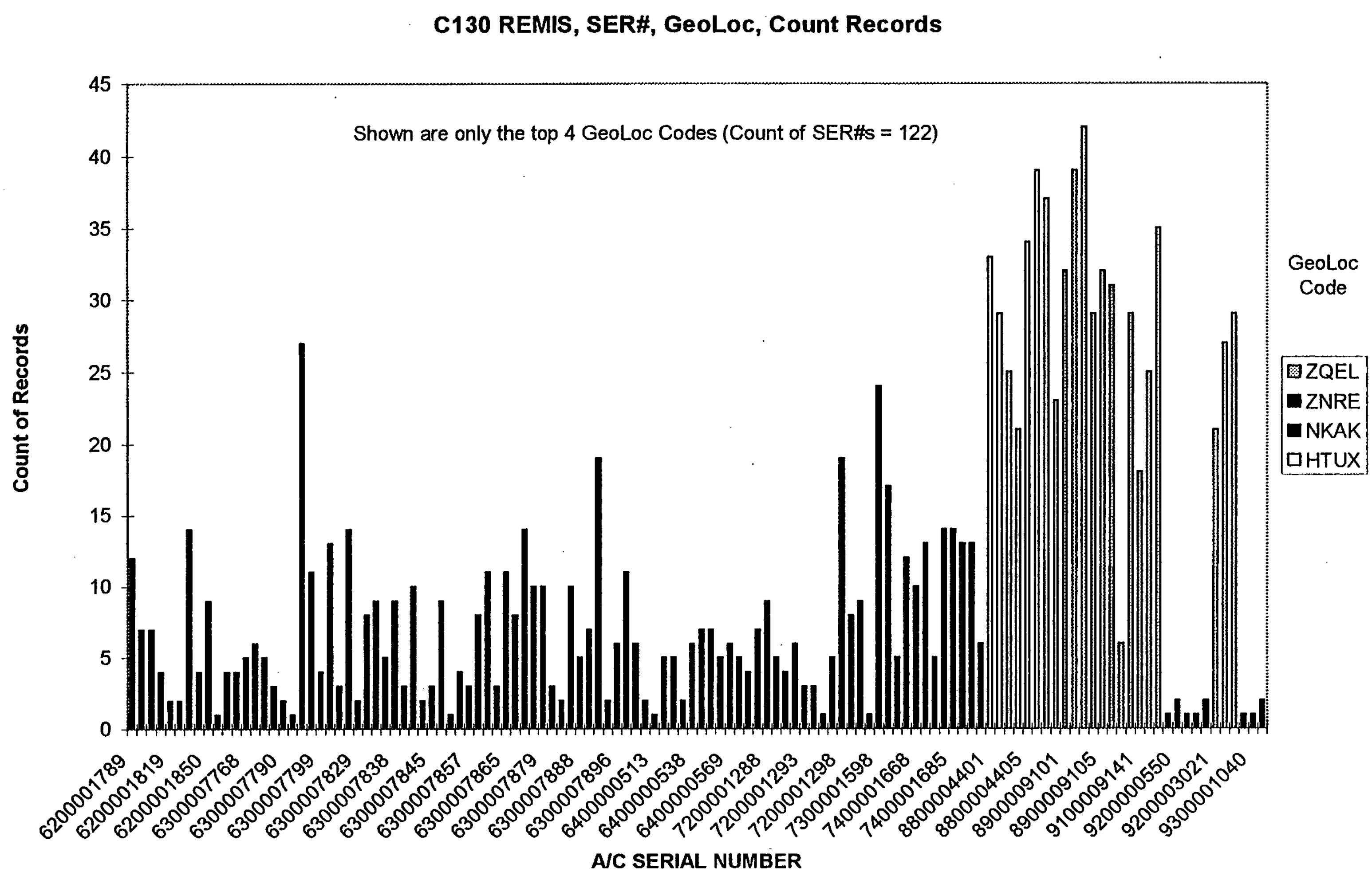

Figure 2. C-130 REMIS, Count Records Grouped by Aircraft Serial Number Cross-Tabbed with the Top 6 Geographic Locations Codes (GeoLoc).

Table 6. C-130 REMIS, Count Records Grouped by Work Unit Code (WUC) and the Sum of Corrosion Occurrences.

C130 REMIS, WUC, Ct Rec, Sum Corr Occurances		
Sum	2922	5045
WORK UNIT CODE	**Count Of Record**	**Sum Of CORROSION OCCURENCES**
11000	245	1007
11500	69	179
11540	36	81
1143C	42	77
11400	47	72
11412	26	69
11299	27	69
11499	40	68
1151V	32	65
1143G	20	61
11431	36	60
1154P	11	58
11310	29	52
11610	37	48
11240	39	48
11321	30	45
1142W	35	44
11280	30	44
11120	32	43
11541	20	42
11270	26	42
11512	25	41
1154Y	20	41
11435	16	41
11420	31	41
11520	25	40
1112G	20	40
11425	14	40
479 other WUC's	1862	2487

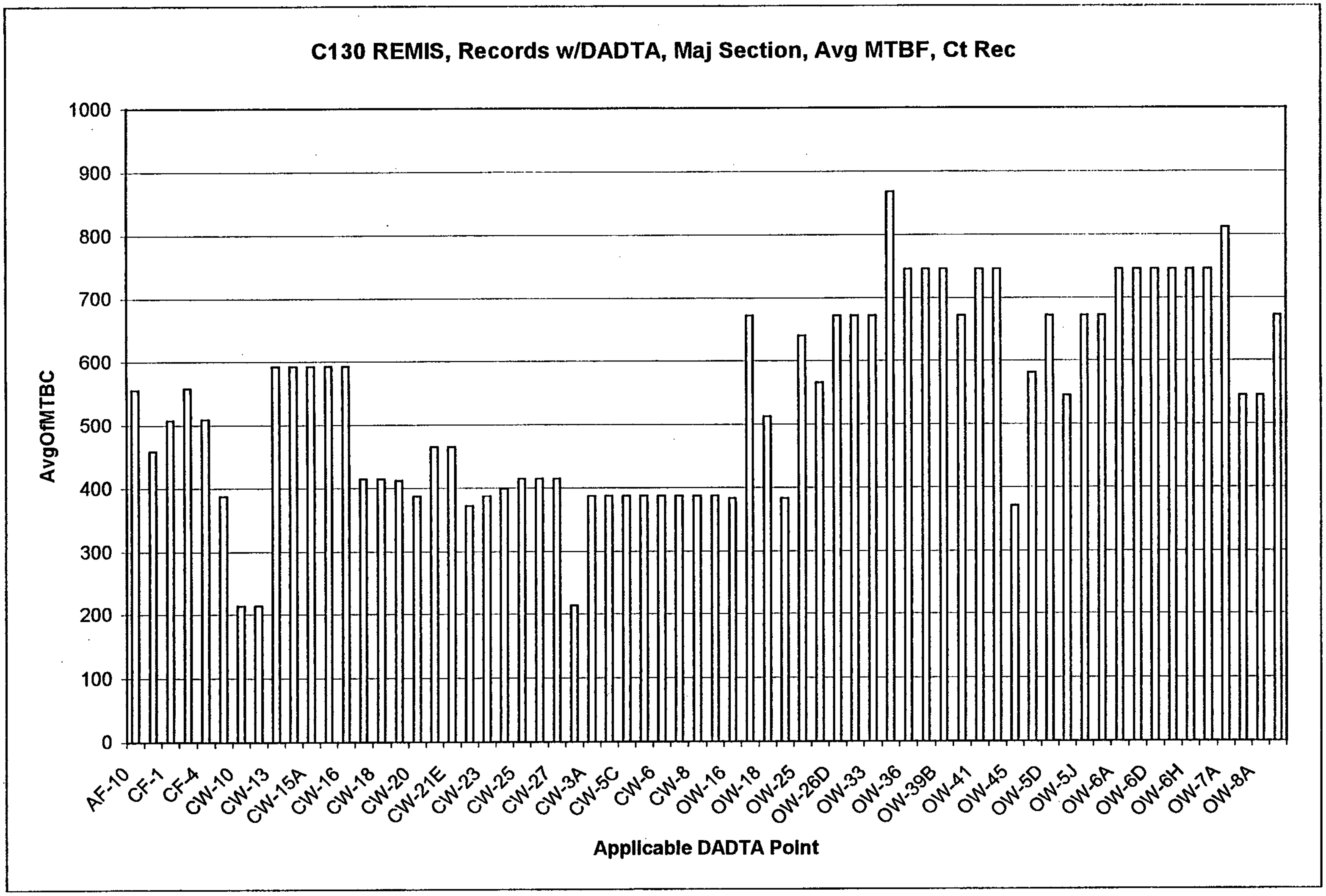

Figure 3. C-130 REMIS, Count Records with DADTA Points Grouped by the Average of the Mean Time Between Corrosion Occurrence (MTBC).

Table 7. List of Data Available in the C/KC-135 OACIS Database

Database File Name:	**KC135OACIS.mdb**	**KC135OACIS.mdb**	**KC135OACIS.mdb**
Table Name:	KC136 OACIS	How Mal Codes	OACIS Field Descriptions
Number of Records:	5883	11	13
Number of Aircraft	279		
Date Range	10/90 - 7/96		
Column Names:	Record	Record	Record
	Work Request Number	How Mal Code	OACIS Field
	Date Reported	Description	Field Description
	Work Unit Code		
	How Mal		
	Action Taken Code		
	When Discovered Code		
	Work Area		
	Work Zone		
	Discrepancy		
	Corrective Action		
	Tail Number		

Table 8. List of OACIS Database Field Definitions

OACIS Field	Field Description
Record	Unique numeric identifier assigned by Access to each record to speed sorting and searching.
Contract Number	Government contract number against which the repair or replacement action was charged.
A/C Serial Number	USAF assigned tail number of the damaged aircraft.
Work Req Number	Number used by DLA to track the discrepancy.
Work Req Date	Date the request for repair or replacement of the damaged component was initiated.
Work Unit Code	Work unit code applicable to the damaged component. TO 1C-xxxx-06.
How Mal Code	Code indicating the type of damage on the component. (170=Corroded Mild/Moderate, 190=Cracked, 667=Corroded Severe)
Action Taken Code	Code indicating the disposition of the damaged component (e.g. repaired or replaced).
When Discovered Code	Code indicating the level of maintenance at which the damage was discovered.
Work Area	Code indicating the general location of the damaged component on the aircraft.
Work Zone	Code indicating the specific zone within the work area in which the damage occurred.
Discrepancy	Narrative describing the damage.
Corrective Action	Narrative describing the repair or replacement action recommended by the responsible engineering activity.

Table 9. List of Queries Included in the C/KC-135 OACIS Access Database (KC135OACIS.mdb)

Names of Queries in KC135OACIS.mdb
KC135 OACIS, H/M, count records
KC135 OACIS, Tail # ?, Date, WUC, W/A, Z, 667&170&190, Ct Rec.
KC135 OACIS, Tail #, 667 170 190, count records
KC135 OACIS, Tail #, Year, 667&170&190, Count Records
KC135 OACIS, W/A, 667 170 190, count records
KC135 OACIS, WUC, 667 170 190, count records

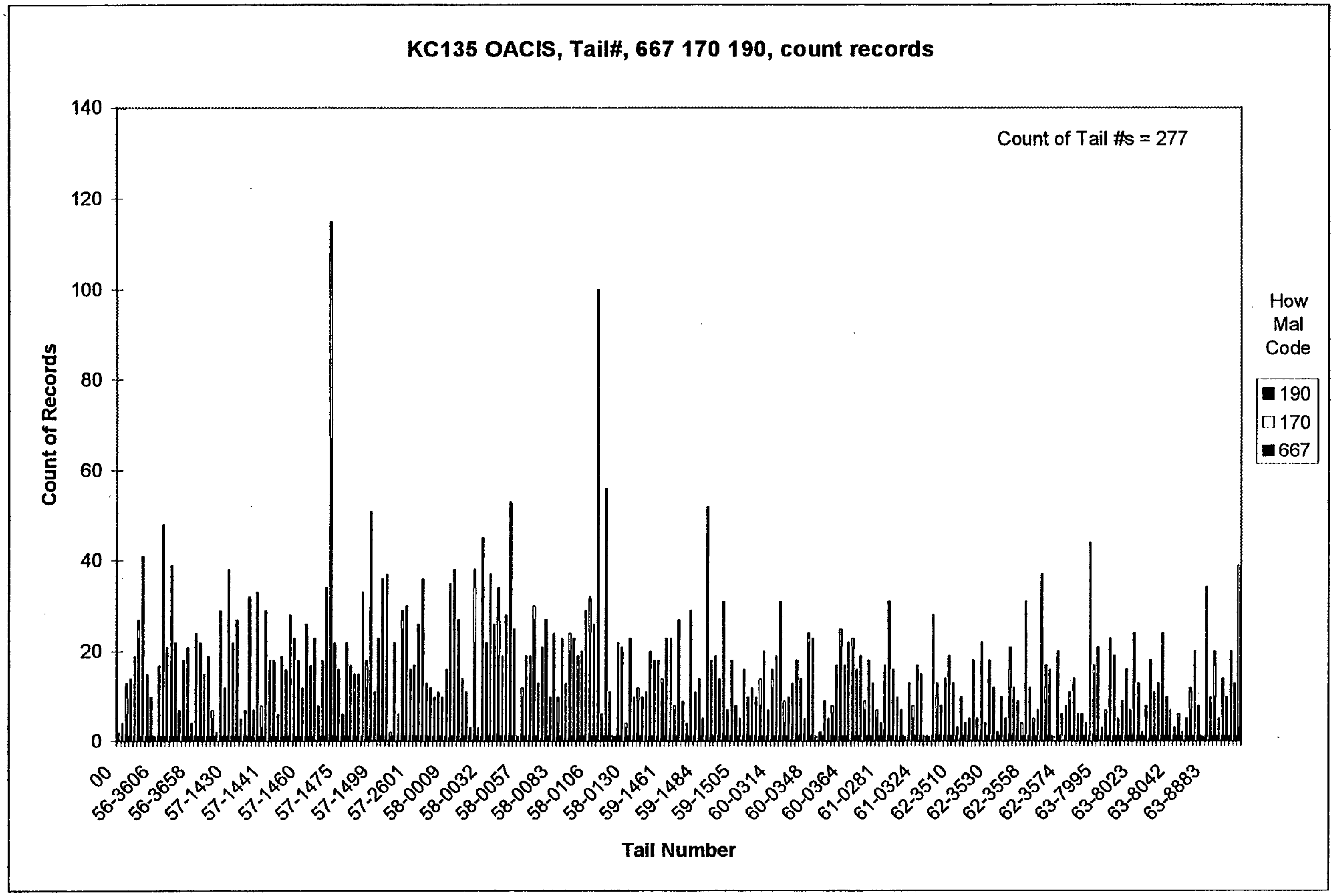

Figure 4. KC-135 OACIS, Count Records Grouped by Aircraft Tail Number and How Malfunction Code (How Mal Code) for Corrosion (667 – severe, 170 – moderate), and Cracking (190 – cracking). Note that cracking damage accounts for 6.7% of the total number of records.

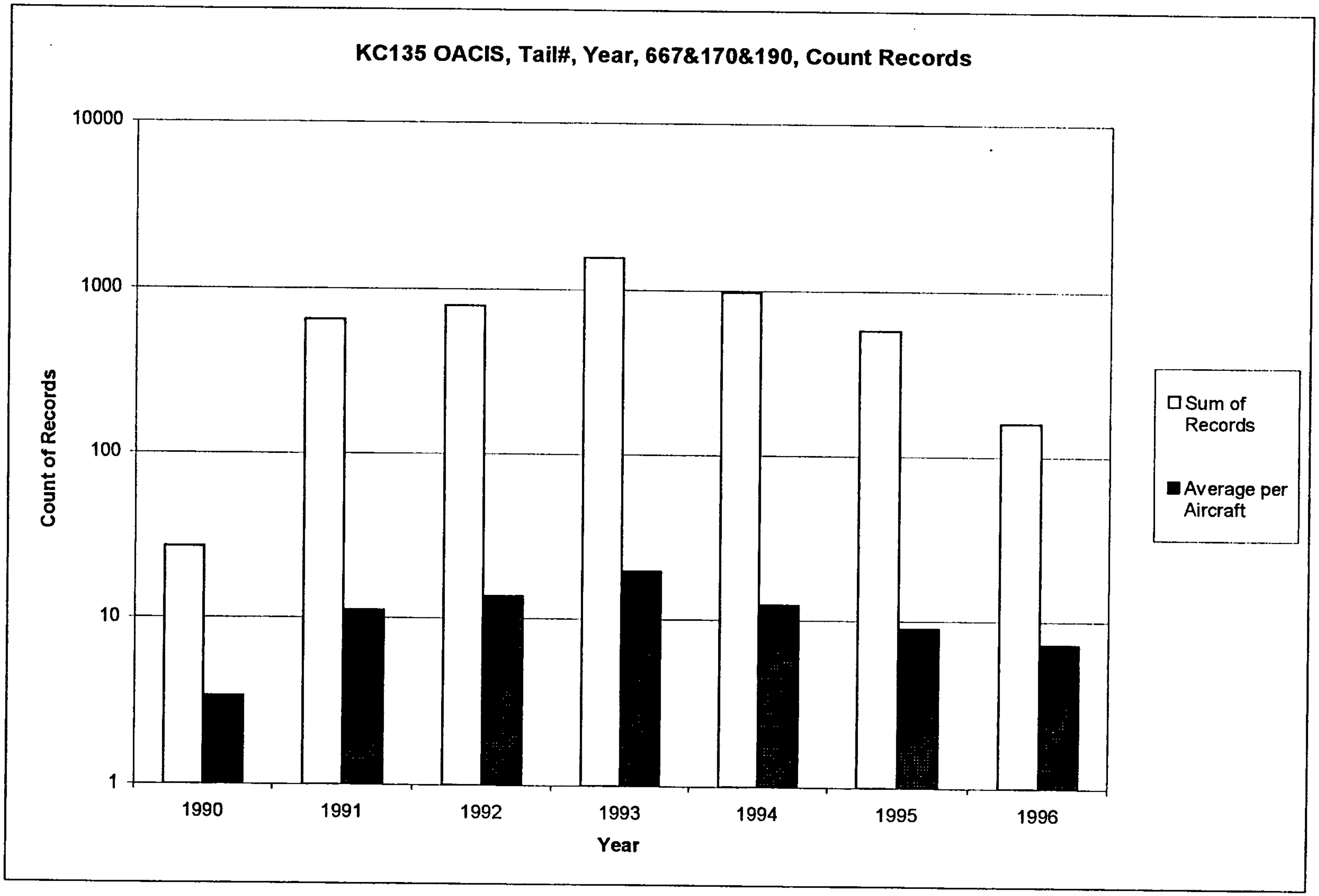

Figure 5. KC-135 OACIS, Count Records Grouped by Aircraft Tail Number and Cross-Tabbed by the Year Repair completed.

Table 10. KC-135 OACIS, Count of Records Grouped by Tail Number and Cross-Tabbed by the Year the Repair was completed.

KC135 OACIS, Tail#, Year, 667&170&190, Count Records

Count of Tail #s =											277
Sum =	47	1	1	27	650	798	1556	981	579	159	4799
Average =	1.27	1	1	3.38	11.2	13.8	19.7	12.4	9.05	7.23	17.2

Year
Count of Records

Tail Number	<>	1901	1963	1990	1991	1992	1993	1994	1995	1996	Sum	Count
62-3578				9	2				2	1	14	4
57-1473	1					23			84	7	115	3
58-0068				5	4				21		30	3
59-1480							4	19	6		29	3
57-1468					17				5	1	23	3
59-1522				4	4				12		20	3
55-3146					10				7	2	19	3
57-2608					9				3	1	13	3
58-0113							99	1			100	2
58-0050							23	30			53	2
57-1497	1					46	4				51	2
56-3609	1				32					15	48	2
58-0015							12	26			38	2
57-1507							35	2			37	2
58-0014							34	1			35	2
63-8883								19	15		34	2
57-1436							30	2			32	2
57-2600								27	3		30	2
57-1428	1				1	27					29	2
58-0102							21	8			29	2
58-0045							27	1			28	2
56-0065						23	4				27	2
58-0016							25	2			27	2
57-2604	2				17	7					26	2
60-0363							3	22			25	2
58-0089								18	6		24	2
63-8023					23	1					24	2
63-8039	1				1	22					24	2
57-1454					11	12					23	2
58-0344						2	21				23	2
59-1464							22	1			23	2
600324							21	1			22	2
56-3622								9	12		21	2
56-3650	1				7				13		21	2
58-0078							17	4			21	2
58-0125							18	3			21	2
63-7995				2	19						21	2
58-0098						1	19				20	2
63-8877						1	19				20	2
63-8888					15	5					20	2
58-0044						15	4				19	2

Tail Number	<>	1901	1963	1990	1991	1992	1993	1994	1995	1996	Sum	Count
58-0060						18	1				19	2
58-0062						18	1				19	2
62-3506									14	5	19	2
56-3641						16		2			18	2
61-0272									17	1	18	2
63-8033						4		14			18	2
60-0362								1	16		17	2
62-3566					10				7		17	2
59-1511							14	2			16	2
62-3569	1				12				3		16	2
63-8018					15					1	16	2
59-1461								4	10		14	2
59-1497								7	7		14	2
55-3143					3				10		13	2
63-8025						1	12				13	2
63-8036					9	4					13	2
64-14837	1					11	1				13	2
57-1429				2	10						12	2
57-1499						10	1				11	2
59-1450								8	3		11	2
58-0004					6					4	10	2
58-0084							2	8			10	2
63-8041						2	8				10	2
63-8015	1				7	1					9	2
57-1469						7	1				8	2
60-0360									1	7	8	2
63-8029									6	2	8	2
56-3640				3	4						7	2
61-0308							5		2		7	2
57-1480					2				4		6	2
58-0114									5	1	6	2
59-1489								4	1		5	2
60-0359									3	2	5	2
63-8005				1	4						5	2
63-8873								4	1		5	2
58-0130									2	2	4	2
63-7991							2		2		4	2
199 other Tail#s with repair records for only 1 year												

Table 11. KC-135 OACIS, List Records for Tail Number = 62-3578 including Year and Discrepancy Description.

14 KC135OACIS, Tail# ?, Date, WUC, W/A, Z, 667&170&190

Tail Number	Record	Date Reported	Work Unit Code	Work Area	Work Zone	Discrepancy
62-3578	255	11/12/90	23JQD	26	9	#4 ENG CLAMP ON AIR DUCT CORRODED TOP PF OIL COOLER TAB
62-3578	256	11/12/90	23JQC	26	9	#4 ENG "B" NUT CORRODED ON DRAIN TUBES AT PILOT VALVE AND TOP PF OIL COOLER TAB RH SIDE OF ENG
62-3578	257	11/12/90	23KSS	26	9	#4 ENG STARTER BLOW OUT PLUG CORRODED
62-3578	258	11/12/90	49422	26	9	#4 ENG 4 EACH CLAMPS CORRODED EXCESSIVE ON FIRE DETECTOR HEAT SHIELD TOP OF ENGINE ON DIFUSER CASE
62-3578	259	11/13/90	23KOO	25	9	#3 ENG AC OUTPUT AND NEUTRAL TERMINALS CONNECTORS CORRODED TOP OF ENG
62-3578	260	11/13/90	23KSS	25	9	#3 ENG STARTER BLOW OUT PLUG CORRODED
62-3578	261	11/13/90	23JQC	25	9	#3 RNG B NUTS ON ENG OIL COOLER CORE AND BY PASS SENSING VALVES CORRODED RT SIDE OF OIL COOLER
62-3578	264	11/15/90	23KOO	23	9	#1 ENG AC OUTPUT & NEUTRAL TERMINAL WIRE LUGS CORRRODED TOP PF ENG -3 WIRES
62-3578	265	11/16/90	23KSS	24	9	#2 ENG STARTER BLOW OUT PLUG CORRODED
62-3578	266	01/02/91	11510	13	6	LH HORIZ STAB NUMEROUS SMALL CORROSION PITS IN FORKS OF TERMINAL ATTACH FITTINGS EXCEDS LIMITS (.01)
62-3578	267	01/18/91	11CFE	4	67	CARGO COMP BELOW FLOOR BS 596 BL 70R 1 1/4' CORR IN PRESSURE WEB
62-3578	5584	01/16/96	11AMO	17	46	RT WING 33 MAIN FUEL LEVEL CONTROL VALVE SUPPORT FITTING CORRODED BEYOND LIMITS
62-3578	5585	11/02/95	11A20	5	39	#3 FW TANK S-25 LH SIDE BS580-575 PULLED SPOT WELDS & SEV CORR (ALSO MOD CORR AT LAPSEAM BS540-600)
62-3578	5586	11/04/95	11A20	5	39	#0 FWD TANK LAP SEAM & SKIN AREA BETWEEN S27 & 26 L/H SIDE BS410-420 SEV CORR & SEVERAL PULLED SPOT WELDS

Table 12. (7 sheets) KC-135 OACIS, List Records for Tail Number = 57-1473 including Year and Discrepancy Description

	115		KC135OACIS, Tail# ?, Date, WUC, W/A, Z, 667&170&190			
Tail Number	**Record**	**Date Reported**	**Work Unit Code**	**Work Area**	**Work Zone**	**Discrepancy**
57-1473	842	02/26/92	11000	16/17	46	SEVERE CORR, TOP OF L/R WING SKINS FROM WING ROOT TO WING TIP
57-1473	843	03/12/92	11KBL	17	46	REMOVE & REPLACE LH WING TIP FWD UPPER SKIN DUE TO SEVERELY CORR AND BROKEN OUT HAT SEC
57-1473	844	03/09/92	11430	12	48	LH KEEL BEAM DR MAG SKIN SEV CORR STA 720-768
57-1473	845	03/04/92	14ALB	19	48	#7 SPOILER TOP OB MAG SEV CORR
57-1473	846	03/04/92	14ALB	18	48	#3 SPILER; TOP MAG SKIN SEV CORR THRU OUT & SCAB PATCH
57-1473	847	04/13/92	11774	17	4/6	RH WING/WS 107-140/#2 PNL PITTED CORR
57-1473	848	03/19/92	11117	12	48	RH AFT BODY FAIRING #3 MAG PNL SEV CORR
57-1473	849	03/19/92	11117	12	48	RH AFT BODY FAIRING #4 PNL SEV CORR & CRKS
57-1473	851	03/30/92	11660	16	46	REMOVE & REPLACE LH UPPER O/B SKIN PANEL DUE TO SEVERE CORR
57-1473	852	03/27/92	11117	12	46	UPPER L/H AFT WING FAIRING FWD MAG SKIN PNL. NUMEROUS CRKS & IG CORR AT FAST.
57-1473	853	04/02/92	11A30	1	46	COCKPIT RH BS 260 SEVERE IG CORR ON BS 260 FRAME
57-1473	854	03/27/92	45210	4	5	CARGO COMPT UNDER FLOOR/BS 370 BL 38R HYD CROSSOVER VALVE CABLES A & B SEVERE CORR
57-1473	855	03/27/92	11A21	4	5	CARGO COMPT UNDER FLOOR BS 370 BL 36R EMERG PRESS RELIEF CABLE SEVERE CORR, RUST
57-1473	856	03/31/92	11KCP	18	46	L/H WG TE WS 354-363/PITTED CORR AROUND FASTENERS CRK EXTENDED PAT 3RD SD & PREV 3X9 SCAB PATCH UPPG
57-1473	857	03/31/92	11KAA	16	46	L/H L/E, SEVERE CORROSION, RIVETS NOT SEATED & LOOSE ON L/E PANEL WLB 63.9 PITTED
57-1473	858	04/03/92	11774	17	46	R/H WG L/E WS 223-140 PITTED CORR AROUND FAST & 1/8 IN CRKS AROUND FAST
57-1473	859	04/02/92	117774	16	46	L/E MAG SKIN EXTERIOR PITTED CORR THRU OUT 1/8 IN CRK AT RIVET, UPPER WBL 129
57-1473	860	04/02/92	11774	16	46	L/H WING L/R MAG SKIN 1/4 IN CRK AT RIVET TOP WITH PITTED CORR THROUT EXT W/S 201
57-1473	861	04/02/92	11774	16	46	L/H WING L/E MAG SKIN W/S; 240-340, 6 CRKS 1/8 - 1/4 IN AT RIVETS TOP & PITTED CORR THRU OUT
57-1473	862	04/02/92	11774	17	46	R/H L/E, WBL 64, HAS; 1/8 IN HOLE IN L/E SKIN TOP SIDE POSSIBLE CORR

Table 12. (7 sheets) KC-135 OACIS, List Records for Tail Number = 57-1473 including Year and Discrepancy Description

	115		KC135OACIS, Tail# ?, Date, WUC, W/A, Z, 667&170&190			
Tail Number	Record	Date Reported	Work Unit Code	Work Area	Work Zone	Discrepancy
57-1473	863	04/13/92	11774	17	46	RH WING W.S. 107-140 #2 PNL PITTED CORR
57-1473	864		1166G	16	46	I/B AIL BAL BAY CAV; SEVERE CORR STILL EXIST ON UPPER I/B & O/B RIB ANGLES(AFTER CLEAN UP)
57-1473	865	04/20/92	11774	16	46	LH WING L/E MAG PNL SCATTERED SEVERE CORR THRU OUT WS 340-360
57-1473	866	04/21/92	11770	19	46	RH WING IB T/E BAL BAY CAV SEVERE EXFOL CORR STILL EXIST AFTER CLEAN UP REQ
57-1473	5247	08/31/95	151O	14	40	RH HORIZ. STAB. (STA 12-47)-BOTT. SKIN ADJACENT TO FWD SPAR & L/E ASSY. MILD CORR SEVERAL THRU-OUT.
57-1473	5248	08/31/95	1151D	14	40	RH HORIZ. STAB. TOP AFT, SNUBBER PNL MILD CORR. THRU-OUT & AROUND FASTS. HOLES.
57-1473	5249	08/31/95	1151D	13	40	LH HORIZ. STAB TOP SKIN BETWEEN FWD & AFT SPARS. SCATTTERED CORR. THRU-OUT
57-1473	5250	08/31/95	1151D	13	40	LH HORIZ. STAB- TOP OF L/E ASSY. SECTION MILD CORR. THRU-OUT.
57-1473	5251	08/31/95	1151O	13	40	LH HORIZ. STAB BOTT. OF #2 BOTT. BAL, BAY ACC. PNL-MILD CORR. @ AFT. & O/B SIDES,
57-1473	5252	08/31/95	1151O	13	40	LH HORIZ. STAB BOTT, OF BOTT #5 BAL. BAY ACC PNL AFT SIDE MILD CORR. UNDERNEATH PHENNNNNOLIC.
57-1473	5253	09/01/95	1151O	13	40	LH HORIZ. STAB. UPPER MAG. SHIM SEVERELY CORR. @ THRUST BEARING ACC PNL
57-1473	5254	12/12/95	14CEO	13	43	LH ELEV CONT TBA #1,3,6,8 WSTS PITTED & IG CORROSION
57-1473	5255	08/31/95	1151O	14	40	RH HORIZ. STA.(STA 50) MILD CORR THRU-OUT TOP SKIN RETURN FWD & AFT SPARS
57-1473	5256	08/31/95	1151O	14	40	RH HORIZ. STAB- TOP SKIN AJACENT TO AFT. SPAR MILD CORR. THRU-OUT
57-1473	5257	08/31/95	1151O	14	40	RH HORIZ. STAB. BOTT. OF BOTT. #5 BAL. BAY ACC. PNL MILD CORR UNDERNEATH PHENOLIC
57-1473	5258	08/31/95	1151O	14	40	RH HORIZ. STAB BOTT. OF BOTT. #2 BAL, BAY PNL MILD CORR. UNDER PHENOLIC
57-1473	5259	08/31/95	1151O	13	40	LH HORIZ. STAB BOTT. OF L/E ASSY, SCATTERED CORR. (MILD) THRU-OUT AROUND FASTS.
57-1473	5260	08/31/95	1151O	13	40	LH HORIZ. STAB. BOTT. L/E OF STAB.-SCATTERED MILD CORR AROUND HD'S

Table 12. (7 sheets) KC-135 OACIS, List Records for Tail Number = 57-1473 including Year and Discrepancy Description

	115		KC135OACIS, Tail# ?, Date, WUC, W/A, Z, 667&170&190			
Tail Number	Record	Date Reported	Work Unit Code	Work Area	Work Zone	Discrepancy
57-1473	5264	08/30/95	1113A	12	95	EXT. FUS, FS-259 RBL-22 DOUBLER REPAIR FWD RH O/B NLG DR OPENING MILD CORR.
57-1473	5265	08/30/95	13FBB	22	95	NLG RH DR SKIN SEVERE CORR.
57-1473	5266	08/30/95	1113A	12	95	EXT. FUS. FS-360 LTC RBL-16 WL-137, AFT OF NLG W/W PENING, MOD TO SEVERE CORR AROUND FASTS.
57-1473	5268	08/30/95	1113A	12	95	EXT. FUS. FS-430-450 & 530-560 AT STR-19R SKIN HAS CORR.
57-1473	5270	08/30/95	1113A	12	95	EXT. FUS. FS-178 TO 259 RH SKIN BELOW CPPILOT'S SIDE WINDOW, 9EA. RIVETS WITH MOD. CORR BLEED OUT
57-1473	5272	08/30/95	1113A	12	95	EXT. FUS. FS-600 RH FUS. TO WING UPPER FILLET FAIRING HAS 12EA. FASTNERS WITH CORR BLEED OUT.
57-1473	5273	08/30/95	1113H	12	95	EXT. FUS. FS-460 WL207 LH 2EA SCREWS WITH CORR BLEED OUT, FWD LWR OF CRK'D DR.
57-1473	5274	08/30/95	1113A	12	95	EXT. FUS. FS-600 LH FUS TO WING UPPER FILLET FAIRING 5EA FASTS. WITH CORR BLEED OUT.
57-1473	5275	08/30/95	1113A	12	95	EXT. FUS. FS320 LH INSIDE CREW ENT DR RELEASE HANDLE COMP. FWD WALL MOD CORR.
57-1473	5277	08/30/95	11299	12	95	CREW ENTRY DR PRESS DR HAS I/G CORR.
57-1473	5278	09/01/95	11JER	17	95	RH WING WS-757-948 MILL AREA & STRAP HAS MOD CORR. T/E.
57-1473	5279	09/01/95	11JER	17	95	RH WS-874 T/E MILL AREA #AS 1'1/2" AREA OF EXFOLIATED CORR.
57-1473	5280	07/30/95	11BBQ	12	95	EXT. FUS, F/S958-955 RBL47, WL28V LAP SEAM HAS EVIDENCE OFF BLEED OUT CORR.
57-1473	5281	07/30/95	11BBN	12	95	EXT. FUS, FS 960, RBL41-50, WL278-273, SKIN PNL HAS EVIDENCE OF BLEED OUT CORR.
57-1473	5282	07/30/95	11DCA	12	95	EXT. FUS. FS 1280-1240, RBL72, WL230-250 7EA. RIVETS HAVE EVIDENCE OF EXFOLIATED CORR AROND RIVET HEADS (STEEL RIVETS)
57-1473	5283	07/30/95	11DCB	12	95	EXT. FUS. FS 1210-1205 RBL72,WL227-230 3EA. RIVETS SHOW EVIDENCE OF BLEEDOUT & CORR AROUND RIVET HEADS STEEL RIVETS.
57-1473	5284	07/30/95	11DCB	12	95	EX.T FUS. FS 1025-1023, RBL72, WL237 2EA. RIVETS HAVE EVIDENCE OF EXFOLIATED CORR AROUND RIVET HEAD/STEEL RIVETS)
57-1473	5285	07/30/95	11BBF	12	95	EXT. FUS. FS660-672, RBL 72, WL232-235 3EA. (SEEL) RIVETS HAVE EVIDENCE OF EXFOLIATED CORR AROUND RIVET HEAD.

Table 12. (7 sheets) KC-135 OACIS, List Records for Tail Number = 57-1473 including Year and Discrepancy Description

	115		KC135OACIS, Tail# ?, Date, WUC, W/A, Z, 667&170&190			
Tail Number	**Record**	**Date Reported**	**Work Unit Code**	**Work Area**	**Work Zone**	**Discrepancy**
57-1473	5286	07/30/95	11BBR	12	95	EXT. FUS, FS 710-770, RBL 72, WL282 LAP SEAM HAS EVIDENCE OF LIGHT BLEED OUT CORR.
57-1473	5287	07/30/95	11BAP	12	95	EXT. FUS, F/S 425-450, RBL 60, WL280 11EA RIVETS HAVE EVIDENCE OF EXFOL. CORR AROUND RIVET HEAD
57-1473	5288	07/30/95	11JBK	12	95	RH WING #4 RESERVE TANK VOPCR SKIN PNL, SEVERE I/E CORR AROUND RIVET HEADS.
57-1473	5289	07/29/95	11BMO	12	95	BS600-620 BLO ACCESS PNL SEVERELY CORRODED AROUND SCREW HOLES AND HINGE POINTS
57-1473	5290	07/29/95	11BLO	12	95	BS725-820 RH LWR WING TO BODY FAIRING SKIN PNL. HAS NUMEROUS RIVETS CORRODED.
57-1473	5291	07/29/95	11BLO	12	95	BS996 RH LWR MAG. SKIN PNL CORRODED RIVETS.
57-1473	5292	07/29/95	11BKO	12	95	BS960, BLO LWR ACCESS PNL. SEVERELY CORRODED.
57-1473	5293	07/29/95	11BKO	12	95	BS960-975 LH LWR SKIN PNL SEVERELY CORRODED AROUND PATCH AND RIVETS
57-1473	5294	07/29/95	11BFD	12	95	RH FS615, BL23R, MODERATE CORR AROUND DRAIN HOLE.
57-1473	5295	07/29/95	11BFD	12	95	RH BS 608 BL 23K, PII LITE AFT FAIRING SEVERE CORR.
57-1473	5296	07/29/95	11BFD	12	95	BS 600-620, BL-0 ACCESS PNL HAS16EA. SCREWS SEVERELY CORRODED.
57-1473	5297	07/29/95	465AN	12	95	EXT. FUS. FS 1355/RBL42, WL270, APPO.X 4 INCHES UPPER DECK VENT BOX DRAIN, RIVET SHEARED & 2 CORR & SKIN BULDGED
57-1473	5298	07/29/95	11DBR	12	95	EXT. FUS. F/S 1327, RBL47, WL280, 3 SQ. IN. SEVERE EXFOLIATED CORR AROUND SONIC STRAP
57-1473	5299	07/29/95	465AN	12	95	EXT. FUS. FS 1230, RBL42, WL290, 3 SQ. IN AFT BODY VENT BOX RIVETS EXFOLIATED CORR & 1EA. RIVETS SHEARED
57-1473	5300	07/29/95	1113G	12	95	EXT. FUS. FS1174-1215, RBL47, WL280, 110 SQ. INCHES) 10EA. RIVETS HAVE EXFOLIATED CORR. (NOTE THESE ARE ON TOP SEAM)
57-1473	5301	07/29/95	1113G	12	95	EXT. FUS, FS1122-970, RBL47, WL280, 15 SQ. IN. 15EA. RIVETS HAVE EXFOLIATED CORR. "NOTE RIVETS ARE ON LAP SEAM)
57-1473	5302	07/30/95	11AAN	12	95	LH FWD FUSELAGE EXT. BS 360 WL282 IG CORR AROUND (1EA) STEEL FAST. (1 SQ./IN.)
57-1473	5303	07/30/95	11BBJ	12	95	LH FUSELAGE CTR SECTION EXT. BS 620 WL242-282 IG CORR AROUND 6EA STEEL FASTS. (12 SQ./IN)
57-1473	5304	07/30/95	11AAP	12	95	LH FWD FUSELAGE EXT. BS 278 WL232 IG CORR AROUND (2EA) STEEL FASTS. (2 SQ/IN)

Table 12. (7 sheets) KC-135 OACIS, List Records for Tail Number = 57-1473 including Year and Discrepancy Description

	115		KC135OACIS, Tail# ?, Date, WUC, W/A, Z, 667&170&190			
Tail Number	Record	Date Reported	Work Unit Code	Work Area	Work Zone	Discrepancy
57-1473	5305	07/30/95	1114H	12	95	LH FWD FUSELAGE EXTERIOR BS 230 BTWN PILOT'S #1 AND #2 WINDOW IG CORR AROUND (EA) STEEL FASTS.
57-1473	5306	07/30/95	11BBK	12	95	LH FUSELAGE CTR SECTION EXT. BS 660-720 WL208-220 IG CORR AROUND STEEL FASTS. (100 SQ./IN)
57-1473	5307	07/30/95	11BBJ	12	95	LH FUSELAGE CTR SECTION EXT. BS 690 WL 270 IG CORR AROUND (2EA) FASTS. (3 SQ./IN)
57-1473	5308	07/30/95	11BBJ	12	95	LH FUSELAGE CTR SECTION EXT. BS 815-825 WL260-275 IG CORR AROUND STEEL FASTS. (15 SQ./IN)
57-1473	5309	07/30/95	11BBR	12	95	LH FUSELAGE CTR SECTION EXT. BS 830 WL220 IG CORR AROUND (4EA.) STEEL FASTS. (6 SQ. IN)
57-1473	5310	07/30/95	11BBR	12	95	LH FUSELAGE CTR SECTION EXT. BS 860-890 WL208 IG CORR AROUND STEEL FASTS. 20 SQ./IN
57-1473	5311	07/30/95	11GBT	13	95	LH HORIZ. STAB. UPPER BAL BAY SKIN PNL E/S 115-160 IG CORR AROUND STEEL FASTS. AT REAR SPAR
57-1473	5312	07/29/95	11BMD	12	95	BS 960-975 LH SKIN PNL HAS 8EA. SEVERELY CORRODED SCREWS
57-1473	5313	07/29/95	11BMD	12	95	BS1007 LH LOWER SKIN PNL. SEVERELY CORR. AROUND SCREWS & INSIDE PNL.
57-1473	5314	07/29/95	11AAG	12	95	RH BS 236 SKIN PNL FWD STATIC PORTS RIVETS CORRODED
57-1473	5315	07/29/95	11BKO	12	95	BS 725-745 LH WING TO BODY LOWER SKIN PNL. RIVETS SEVERELY CORRODED
57-1473	5316	08/25/95	1113D	12	95	EXT. FSUE, BS660 TO 730 WL 160, BL 48 RT, 1EA. MAG. SKIN PNL CORRODED.
57-1473	5317	08/25/95	1143D	12	95	RT. KEEL BEAM DOOR, STA 770-820, 1EA MAG. SKIN PNL CORRODED
57-1473	5318	08/25/95	11117	12	95	FUSE, BS 1085, RH BODY FAIRING HAS 1EA ACCESS PNL CRK'D/CORRRODED.
57-1473	5319	08/25/95	1113G	12	95	EXT. FUSE, BS 1170, AFT BODY TANK ACCESS DOOR PNL CORR
57-1473	5321	08/25/95	11117	12	95	EX.T FUSE BS 1040 TO 1080, LT. AFT BODY MAG. FAIRING CORR
57-1473	5322	08/25/95	11117	12	95	EXT. FUSE, BS960 TO 980, LT. AFT BODY MAG. FAIRING CORR.
57-1473	5323	08/25/95	1113D	12	95	EXT. FUSE BS 660 TO 730 WL160, BL 48 LT. 1EA. MAG. SKIN PNL CORRODED.
57-1473	5324	08/25/95	1113D	12	95	EXT. FUSE, BS 820 WL136-156, LT, MAG. FILLER PNL. CRK'D CORRODED.
57-1473	5325	07/29/95	1113D	12	95	EXT. FUS. BOTTOM SKIN B/S422 RBL 3.5 MOD. CORR ON SKIN AROUND SCREW,

Table 12. (7 sheets) KC-135 OACIS, List Records for Tail Number = 57-1473 including Year and Discrepancy Description

	115		KC135OACIS, Tail# ?, Date, WUC, W/A, Z, 667&170&190			
Tail Number	Record	Date Reported	Work Unit Code	Work Area	Work Zone	Discrepancy
57-1473	5326	07/29/95	1113D	12	95	EXT. FUS. BOTTOM SKIN BS 440 RBL12 MOD CORR ON SKIN 1/8" X 1/4"
57-1473	5327	07/29/95	1113D	12	95	EXT. FUS. BOTTOM SKIN BS462, LH BL11, 5-MOD. CORR ON SKIN 1/4" DIA.
57-1473	5328	07/29/95	1113D	12	95	EXT. FUS. BOTTLOM SKIN BS 469 RBL13.5 MOD. CORR ON SKIN AROUND RIVET
57-1473	5329	07/29/95	1113D	12	95	EXT. FUS. BOTTOM SKIN BS 503 LBL 12 MOD. CORR ON SKIN 1/4" DIA. 1/8" DIA. & LBL9-RBL6 MOD CORR. ON SKIN AROUND 16EA. RIVETS.
57-1473	5330	07/29/95	1113D	12	95	EXT. FUS. BOTTOM SKIN BS 530 LBL 12 MMOD CORR ON SKIN AROUND 2EA RIVETS
57-1473	5331	07/29/95	1113D	12	95	EXT. SKIN BS 560 RH BL 9 MOD CORR ON SKIN AROUND RIVET BS 559-560-LBL1-RBL3/MOD CORR ON SKIN AROUND RIVET 4EA
57-1473	5332	07/29/95	1113D	12	95	EXTERIOR FUS. BOTTOOM # FWD BODY TANK ACCESS PNL BS 567 RBL12 MOD. CORR 1/2" DIA.
57-1473	5333	07/29/95	1113D	12	95	EXT. FUS. BOTTOM SKIN BS 580 LBL9&11 MOD. CORR ON SKIN AROUND SCREWS 1/2" DIA. & 1/4" DIA.
57-1473	5334	07/29/95	1113D	12	95	EXT. FUS. BOTTOM SKIN BS 604 RBL14 MOD. CORR SKIN AROUND DRAIN SCREW
57-1473	5335	07/29/95	11000	18	95	BOTTOM LH WING T/E STA 733-753 SKIN PANEL I/B EDGE AFT AREA & AFT EDGE AREA MOD CORR 2X1/2-1/4"
57-1473	5336	12/01/95	11117	12	95	EXT FUSELAGE BS960-980 LEFT AFT BODY PNL FAIRINGS CORR REMOVAL EXCEEDS T.O. LIMITS
57-1473	5338	10/26/95	1113G	12	95	#2 AFT BODY ACC DR CORR & CRK BEYOND 3-4 LIMITS
57-1473	5339	10/30/95	11JBK	17	95	RH OB WG UPPERSKIN PNL WS733-960 EXF CORR BEYOND T.O. 3-4 LIMITS OF .010 PNL THICKNESS AT POINT OF CORR
57-1473	5340	03/19/96	1113A	12	95	RH FUSELAGE BS600 ABOVE S-25 SKIN ATTACH ANGLE & BRACKET SEVERE CORR
57-1473	5341	03/19/96	1113A	12	84	RH FUSELAGE SKI BOTT LAP BS420 TO 600 WL139 MOD TO SEVERE CORR 25" SQUARE
57-1473	5342	03/20/96	1113D	12	95	FABRICATE LH LWR ACCESS PANEL PER SAMPLE BS960 BL0 DUE TO SEVERE CORR & 0 BALANCE
57-1473	5343	05/02/96	51537	17	95	RT WG LE STA787 FUEL QUANTITY ELEC CONNECTOR CORRODED & PART BROKEN OFF

Table 12. (7 sheets) KC-135 OACIS, List Records for Tail Number = 57-1473 including Year and Discrepancy Description

	115		KC135OACIS, Tail# ?, Date, WUC, W/A, Z, 667&170&190			
Tail Number	**Record**	**Date Reported**	**Work Unit Code**	**Work Area**	**Work Zone**	**Discrepancy**
57-1473	5344	07/17/96	46410	5	95	'O' F/B LT SIDE STA365 LBL49 SEVERE IG CORR ON BACKING BOARD ATTACH ANGLE AT EYELET
57-1473	5345	07/17/96	46410	5	45	'O'F/B LT SIDE STA360 TO 380 BACKING BOARD NUT PALTES 11EA SEVERLY CORRODED
57-1473	5346	07/10/96	46410	5	95	'O' F/B LT SIDE STA360 BULKHEAD LBL32 TO 45 CORR AROUND AIR LINE COVER ATTACH HOLES & RIVETS 8EA

SECTION 4 – CONCLUSIONS AND RECOMMENDATIONS

4.1 Prevention, Detection, and Repair

4.1.1 Short Term

In the near term, the primary Air Force response to airframe corrosion must lie in its traditional methods of prevention, detection, and repair. Technology development efforts to support these activities are largely in place, and are proving successful. A major effort to develop inspection methods capable of detecting hidden corrosion damage is yielding a number of promising techniques, some of which are nearing readiness for field deployment. A number of innovative repair methods, such as the composite reinforcement of weep-holes in the wings of C-141 aircraft, have been developed and deployed. The imminent abolition of chromates has prompted a significant effort to develop improved (and safer) corrosion prevention compounds.

Improvements in corrosion resistance are also available through the use of modern alloys and processes to replace older products currently used in many Air Force aircraft. This approach has been taken in a number of instances on a case-by-case basis. The current implementation route is, however, costly and time-consuming, since each unique substitution requires re-evaluation and re-qualification. The are certainly a number of cases in which the mechanical attributes of the newer material equal or exceed those of the material being replaced. In such instances, replacement of the older material with a newer, more corrosion-resistant product should be possible on the basis of simple material tests alone. Replacement of some older materials could be greatly facilitated by a "preferred replacement material" list, conceptually similar to existing preferred spare programs. Compilation of such a list would allow direct substitution of newer materials for older materials with known susceptibility to corrosion (e.g., 7075-T6) without re-design or re-qualification in components meeting specified criteria for load level and flight criticality. Such an approach would significantly increase the speed and efficiency of material substitution efforts, allowing the benefits of more corrosion-resistant materials to be realized on a broader scale and in a much more efficient manner than is currently possible.

4.1.2 Long Term

Although continued developments in materials, processing, and corrosion prevention measures will continue to increase the corrosion resistance of aluminum aircraft structures, it is very unlikely that such measures, singly or in combination, can ever completely eliminate the development of corrosion damage. Prevention, detection, and repair of corrosion damage will thus remain an essential element of Air Force fleet management procedures for the foreseeable future. Continued development and implementation of improved CPC's, inspection tools and methods, and corrosion damage repair processes is thus not only warranted, but essential.

Incorporation of newer, more corrosion-resistant alloys and product forms into new aircraft is a key route to improving their corrosion resistance. Corrosion-resistant products have often been ignored in favor of their more traditional counterparts due to the considerations of cost, availability, and familiarity. This practice has continued, in part, because corrosion resistance, though considered during the design of the aircraft, is not an explicit performance requirement. Incorporating corrosion resistance into design specifications would provide more visibility to the issue. The corrosion resistance of new aircraft designs should also be evaluated during the development process to assure that opportunities to enhance corrosion resistance have been fully exploited.

4.2 Damage Mechanics

4.2.1 Short Term

It is unlikely that a damage mechanics approach to airframe corrosion can be fully developed within the short-term. Complete development and implementation of such an approach will probably require some number of years, and a significant investment on the part of the Air Force. While completion of so extensive an effort cannot be anticipated in the near term, focused efforts toward this end should be initiated rapidly, in order to assure that the tools needed for management of the Air

Force aging aircraft fleets are available as average fleet ages, and the attendant corrosion problems , continue to rise into the future.

Some activities necessary to support longer-term development efforts for the damage mechanics approach can be identified and implemented quickly. One such activity is collection of aircraft material containing naturally occurring corrosion damage. Such material can be obtained from maintenance activities and/or retired aircraft. This archive material is essential to the development of a damage mechanics tools for assessing the implications of corrosion damage on aging aircraft. The natural corrosion damage found in this material provides the necessary baseline for evaluating the pertinence of artificially induced corrosion damage to aircraft service. Moreover, archive material provides a much more accurate representation of the material in aging aircraft fleets, since more recently produced materials, while nominally identical to the archive materials, have benefited from improvements in processing that are likely to have improved the resistance to corrosion damage. Current Air Force activities to assemble a "bone yard" of corroded archive material should be expanded in scope to include undamaged material (needed to define baseline performance so that the effects of corrosion can be defined) and in scale.

A second short-term activity to support longer-term development of a damage mechanics approach to corrosion is a limited amount of exploratory testing. Such tests would be of significant benefit to the Air Force aging aircraft/corrosion program. Results from a modest test series would help to estimate the scope and severity of corrosion damage with respect to airframe structural integrity. In particular, these results would serve to confirm the deleterious effects of corrosion damage on those aspects of material response critical to airframe structural integrity, such as tensile strength, ductility characteristics, and fatigue/residual strength response. They would also yield quantitative estimates of the extent to which corrosion damage degrades critical material properties.

A second benefit of a limited exploratory testing effort is to define a baseline for establishing the ability of various artificial corrosion protocols, existing and yet to be developed, to produce corrosion damage having effects on structural performance similar to those of naturally occurring corrosion damage. Efforts to date to develop

such corrosion simulation protocols have been based on duplication of damage appearance and chemical composition of the corrosion products. While it is logical to expect that similar levels of naturally and artificially induced corrosion damage will yield commensurate mechanical effects, this fundamental point has yet to be demonstrated. The limited objectives of the exploratory testing activity would thus be:

1) Confirm the deleterious consequences of corrosion damage on key material characteristics that are essential to airframe structural integrity;
2) Estimate the extent to which critical material characteristics can be degraded by corrosion damage;
3) Establish a baseline to verify the ability of laboratory corrosion simulation protocols to replicate the consequence of naturally occurring corrosion damage on critical aspects of material behavior.

The third activity which can (and should) be at least initiated in the short-term is detailed characterization of corrosion environments for Air Force aircraft. Both global and local levels of moisture and concentrations of corrosive chemical species such as chlorides, sulfates, and nitrates need to be defined for aircraft as functions of operating and inactive time. Such activity will need to be conducted for a variety of aircraft at a variety of operating locations. The results would then be used to define generic spectra akin to TWIST and FALSTAF for subsequent use.

4.2.2 Long Term

A focused technical plan has been formulated to meet the anticipated Air Force needs associated with the implications of corrosion damage to management of its aging aircraft fleets. This technical plan is based on the premise that corrosion may be treated as a material condition, which can be modeled in terms of mechanical damage such as fatigue cracks. The structural implications of the corrosion damage to the material can then be defined with conventional analytical methods which are wholly consistent with the existing technical infrastructure for evaluating the structural implications of mechanical damage. The plan consists of six main elements:

1) Defining quantitative metrics for naturally occurring corrosion damage;
2) Simulate naturally occurring corrosion damage in the laboratory;
3) Define implications of corrosion damage to the mechanical behavior of corroded material;
4) Define the structural implications of corrosion damage;
5) Project the structural integrity implications of corrosion damage during future airframe service;
6) Define the current and future structural implications of damage remediation activities.

Brief descriptions of each of these tasks, subtasks, and elements are provided below. Further details are also provided in a chart format in Table 13 in order to define future test requirements and needs.

1. Define quantitative metrics for naturally occurring corrosion damage. Corrosion damage occurs in a variety of forms, including gross loss of material over a large region, localized pitting, and intergranular attack. These different physical forms of corrosion damage will have different effects on the mechanical behavior of the host material. A systematic evaluation of corrosion will therefore require that physical metrics for the various types of corrosion damage be defined and that these metrics be used to characterize naturally occurring corrosion damage. These metrics must be capable of meeting a range of needs, from field inspection of aging aircraft to laboratory research of corrosion processes. The results of this effort will both guide the development of the corrosion simulation protocol(s) and serve as the basis for characterizing the extent of corrosion damage in actual service airframes. This effort must be closely coordinated with ongoing developments in the methods used to detect hidden corrosion damage.

2. Simulate naturally occurring corrosion damage in the laboratory. Although corrosion is common in aging airframes, it is rarely uniform in either intensity or spatial

distribution over any region of substantial size. Naturally corroded material is thus rarely suitable for systematic evaluations of the implications of corrosion damage. A laboratory protocol that creates corrosion damage physically identical to that which occurs naturally, in an abbreviated time frame, is therefore needed to support subsequent elements of the technical plan. This protocol would also serve as a tool for evaluating the corrosion resistance of new and/or replacement materials.

3. Define the implications of corrosion damage to the mechanical behavior of corroded material. The basic premise of the technical plan is that corrosion damage will degrade the mechanical performance of the host material. The relationship between type and level of corrosion damage and type and level of degradation in material performance must thus be defined. This element of the technical plan thus consists of a number of test programs that will be defined to establish the link between corrosion damage and mechanical performance of the damaged material. Results of these tests will be used to define the mechanical model(s) of corrosion damage that will be used for evaluating airframe structural integrity.

4. Define the structural implications of corrosion damage. The effects of corrosion damage on the structural integrity of an airframe are not solely dependent on the properties of the corroded material. These properties must be integrated with the effects of structural configuration and damage distribution to define the effects of the damage on the serviceability of the airframe. The link between corrosion damage to material and airframe structural integrity will be defined with this element of the technical plan.

5. Project the structural integrity implications of corrosion damage during future airframe service. While airframe operators need to know the current level of airframe structural integrity, many of their maintenance and procurement decisions require projections of changes in the structural integrity level during future service. This element of the technical plan will produce the tools and methods which will allow changes in airframe structural integrity to be analytically predicted.

6. Define the current and future structural implications of damage remediation activities. Service life extension will certainly entail some amount of damage remediation, which may range from patching of damaged regions to replacement of major airframe structural components. These remediation actions will necessarily affect the structural integrity of the airframe. Quantitative definition of the implications of alternate remediation actions, including potential opportunities to enhance airframe performance and/or durability through use of newer and improved materials, will be needed to define appropriate actions and to schedule further inspection/repair activities. This element of the technical plan will produce the tools and methods needed to assess the structural integrity implications of damage remediation options.

Table 13. (3 sheets) A program to develop a damage mechanics approach for corroded airframe structures.

Task Title	Subtask Title	Element Title
1. Define quantitative metrics for naturally occurring corrosion damage	1.1 Define metrics for physical characteristics of corrosion damage	a. Define pertinent type(s) of damage b. Dimensions of individual damage sites c. Shape of individual damage sites d. Extent of damage e. Other salient characteristics
	1.2 Define physical characteristics of corrosion products	a. Define pertinent type(s) of damage b. Density of corrosion products c. Consistency of corrosion products d. Amount of corrosion products
	1.3 Define chemical characteristics of corrosion products	a. Define pertinent type(s) of damage b. Composition(s) of corrosion products c. Dominant chemical species
	1.4 Define density distribution(s) of naturally occurring corrosion damage	a. Define pertinent type(s) of damage b. Define distribution(s) by physical characteristics c. Define distributions by chemical characteristics
	1.5 Develop quantitative damage models	a. Define pertinent type(s) of damage b. Dimensions of individual damage sites c. Shape of individual damage sites
	1.6 Develop necessary NDE/I tools/techniques	a. Define corrosion detection requirements b. Assess current NDE/I capabilities vs. requirements c. Identify development requirements d. Develop necessary tools and techniques
2. Simulate naturally occurring corrosion damage in laboratory	2.1 Identify corrosive environment(s)	a. Chemical composition(s) b. Temperature c. Humidity d. Acidity
	2.2 Establish exposure protocols	a. Define geometry effects b. Establish preliminary treatments c. Develop protection systems d. Establish exposure environments e. Define exposure cycles
	2.3 Confirm similitude of simulated corrosion damage effects	a. Physical characteristics of corrosion damage b. Chemical characteristics of corrosion damage c. Damage density distributions d. Effects on static properties e. Effects on cyclic properties f. Effects on durability/damage tolerance properties

Table 13. (3 sheets) A program to develop a damage mechanics approach for corroded airframe structures.

Task Title	Subtask Title	Element Title
3. Define implications of corrosion damage to the mechanical behavior of corroded material	3.1 Define effects on static strength properties	a. Tensile strength properties b. Ductility properties c. Stiffness properties
	3.2 Define effects on cyclic strength properties	a. Smooth-specimen fatigue properties b. Open-hole-specimen fatigue properties c. Smooth-specimen breaking load d. Open-hole-specimen breaking load
	3.3 Define effects on durability/damage tolerance properties	a. Fatigue crack growth rates b. Fracture toughness c. R-curve behavior
	3.4 Define effects on future corrosion resistance	a. With remedial action(s) b. Without remedial actions
4. Define the structural implications of corrosion damage	4.1 Define critical corrosion damage sites	a. Deterministic description b. Probabilistic description
	4.2 Develop equivalent damage models	a. Section loss b. Equivalent crack
	4.3 Incorporate corrosion damage models into existing damage evaluation protocols	a. Implement corrosion damage models into evaluation tools b. Verify and qualify modified tools c. Issue for use d. Maintain
	4.4 Develop corrosion damage assessment guidance	a. Define handbook format/contents b. Define update process c. Develop damage evaluation handbook(s) d. Issue and maintain
5. Project the structural integrity implications of corrosion damage during future service	5.1 Project damage evolution with future use	a. Further corrosion damage b. Interactions between damage types c. Interactions between existing and future damage
	5.2 Define structural implications of damage evolution	a. Define critical structural locations b. Determine current levels of structural integrity c. Project changes in structural integrity with further service
	5.3 Define inspection/maintenance/repair intervals	a. Define critical damage levels b. Define service intervals between existing and critical damage levels c. Define inspection intervals and levels d. Define maintenance intervals and levels

Table 13. (3 sheets) A program to develop a damage mechanics approach for corroded airframe structures.

Task Title	Subtask Title	Element Title
6. Define the current and future structural implications of damage remediations	6.1 Define repair options	a. Material removal b. Patching c. Additional reinforcement d. Component replacement/upgrading
	6.2 Define present structural implications of repair actions	a. Material removal b. Additional fasteners c. Crevice introduction d. Replacement options
	6.3 Define future structural implications of repair actions	a. Impact on structural integrity projections b. Impact on inspection intervals and levels c. Impact on maintenance schedules d. Cost

4.2.3 Feasibility

The likelihood of success for a damage mechanics approach to corrosion of aluminum aircraft structures is reasonably high. Many elements of the development effort parallel those for existing damage mechanics methods for evaluating mechanical damage, and many have also been demonstrated to some degree (though much remains to be done). There is, however, some question about the feasibility of characterizing aircraft service environments in a way that is sufficiently accurate and precise for fleet management purposes. This concern is predicated on the large number of basing locations, operating histories, and maintenance levels that may exist within a given fleet. The resultant variability in service histories could, of course, be addressed with statistical tools, which will have to be introduced for fleet management purposes in any event. At this point in time, however, it cannot be guaranteed that the scatter in the service environment data will not be large enough to mask the desired information.

It must also be recognized that the development of the damage mechanics approach is a large and complex undertaking. Completion of this effort will require a long-term commitment of significant resources by the Air Force, as well as other involved agencies. Setbacks and unforeseen contingencies are virtually certain in a program of this magnitude, and both cost and schedule are almost certain to increase beyond original estimates. The level of commitment required should be thoroughly understood before any effort is initiated.

4.3 Service History Data

4.3.1 Short Term

Service history data probably offer the most means of developing some insight into future corrosion performance of aging Air Force aircraft fleets. Extrapolation of service history data can certainly be expected to yield some results, albeit of uncertain validity, in a much shorter time frame than will development of a damage mechanics

approach. Service history data will thus remain a potentially valuable tool for the management of aging fleets.

While current efforts to collect, compile, and categorize service history data should be continued, the most immediate need with respect to service history data would seem to be an informed assessment of its true potential for managing aging Air Force aircraft fleets. Unless and until such an evaluation is completed, the ultimate value of the data collection efforts must remain unknown. It is therefore recommended that, as service history databases are being developed, they be critically evaluated to define their actual information content. Statistical evaluations should be conducted to determine the ability of these databases to support forward extrapolation of corrosion trends. Shortcomings in the data need to be identified, and judgments made concerning the feasibility of remedying those shortcomings.

Assuming that no insurmountable obstacles are uncovered by the initial assessments, compilation and cataloging of service history data should be continued. Such information must be more detailed and definitive than much of the existing archive data. The service history of individual aircraft, including environmental exposure histories and inspection/repair activities related to corrosion, will need to be recorded. Incidences of corrosion damage must include the type(s), degree, and extent of corrosion damage found, in as quantitative a way as is possible. The types and locations of parts affected by corrosion damage much be defined, as well as their constituent materials and product forms. In short, a concerted effort to define and document airframe corrosion damage in detail must be instituted and enforced.

Air Force fleet management needs cannot be met by data collection alone. Statistical tools to process the data, assess its validity, and define real trends over time will also be needed. These tools must be relatively sophisticated and robust. Robustness is required to accommodate the high degree of variability in both detail and quality of existing data, which will necessarily form the bulk of the available service history information for the immediate future. While improved data collection methods and procedures may ultimately result in more consistency in the service history databases, the variability inherent to the corrosion process is expected to continue to require very robust modeling tools.

While statistical modeling tools for service history data must be robust, they cannot be crude. On the contrary, a high degree of sophistication is needed. The variable levels of quality and level of detail that are found in existing service history data make extraction of meaningful trends a challenging process. In addition, it will require some exceptionally powerful and capable tools. The process is further complicated by the recurring changes to the corrosion status of Air Force aircraft due to maintenance and repair activities. Indeed, statistically based procedures for sorting or other pre-treatment of historical data may be needed before any evaluation of the data *per se* can be started.

Sophisticated statistical tools will also be needed for forward extrapolation of service history data trends. The continued development of corrosion damage greatly complicates the task of extrapolating past trends, and statistical tools capable of incorporating this continuing damage accrual will clearly be needed. Like the tools needed for defining past trends, the tools for future projection must also be capable of incorporating effects such as repair and maintenance activities, and the consequent changes to the state of corrosion damage within an aircraft.

4.3.2 Long-Term

The short-term activities of compiling and assessing service history data and developing the statistical tools needed to process it need to be continued as long as the Air Force desires to use service history data as a basis for fleet management decisions. The data collection process will undoubtedly be refined (and, hopefully, simplified) by the results of ongoing assessments of previously collected data. Such assessments will serve to define the principal environmental and service factors which drive the accrual of corrosion damage, and may allow some of the factors now thought necessary for prediction of future corrosion damage to be omitted from the data collection process. It is, of course, also possible that additional factors not currently identified will be found to be significant drivers of corrosion damage and will have to be added to the data collection process. At this point in time, however, the long-term data collection needs is expected to be essentially those identified for shorter-term activities. Although, advances in inspection methods/tools for characterizing damage and

improved procedures for environmental exposure characterization will undoubtedly lead to more precise and detailed information than can be obtained with current technology.

Data evaluation activities conducted in the short term are also expected to provide some guidance for longer-term development of statistical evaluation tools. Initial attempts at data evaluation are expected to be unsuccessful to some degree, and the failures will yield important lessons concerning the needs for development of statistical tools. The development process will also be impacted by the expected increase in both the quality and detail of service history data, as improved tools and processes for collection of that data are placed into service. The expected increase in the quality and level of detail of service history data is likely to reduce the need for robustness in statistical evaluation tools to some degree. Increasingly sophisticated tools are likely to be needed, however, to accommodate the increasing amounts of data. Such tools will be particularly important to the identification of key parameters for predicting and characterizing corrosion damage, thereby reducing the burden of data collection.

4.3.3 Feasibility

The likelihood of success for developing a corrosion prediction model based on service history data is also reasonably high. The main focus of the development efforts is to construct a database common to all USAF fleets that is designed to archive corrosion damage and repair records. Several critical elements are summarized below.

- The development and transition to the depot and field of NDI tools that can quantify the corrosion damage.
- The recording of the NDI data records with the repair data.
- The determination and recording of the environmental exposures.
- A commitment to quality recording of required data.
- The application of applicable statistical tools.
- An understanding of the limits of application of the data included in the database.

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784612 199509-R5-0901

Effect of the corrosion fatigue testing frequency on the crack growth rate and its model for metals.

Uehara, O ; Higo, Y ; Nunomura, S

CORPORATE SOURCE: Tokyo Institute of Technology

CONFERENCE: Fatigue 93. 5th International Conference on Fatigue and Fatigue Thresholds. Vol. II, Montreal, Quebec, Canada, 3-7 May 1993 745-750

PUBL. DATE: 1993

PUBL: Engineering Materials Advisory Services Ltd., 339 Halesowen Rd., Cradley Heath, Warley, West Midlands B64 6PH, United Kingdom, 1993

COUNTRY OF PUBLICATION: United Kingdom

JOURNAL ANNOUNCEMENT: 9509

DOCUMENT TYPE: Conference Paper

LANGUAGE: ENGLISH

ABSTRACT: The effect of the testing frequency on the corrosion fatigue of metals has been studied to understand the effect of environment. At a frequency range of 0.05-50 Hz, a 7075-T6 aluminium alloy and 304 and 316L stainless steels were fatigue tested in 3.0% NaCl solution. The increments in the fatigue crack growth rate due to the corrosive environment were well explained by a model considering the chemical reaction on a fresh surface during a load cycle. The effect of the frequency in the corrosion fatigue test seems to be the key to understanding the process. Graphs. 4 ref.

DESCRIPTORS: Conference Paper; Aluminum base alloys-- Mechanical properties; Austenitic stainless steels-- Mechanical properties; Corrosion fatigue; Crack propagation-- Corrosion effects; Al Zn Mg Cu alloys

ALLOY INDEX(IDENTIFIER): 7075-- AL

SECTION HEADINGS: R5 (Mechanical Properties)

2.

199036 84-640012

A Superposition Model for Corrosion-Fatigue Crack Propagation in Aluminum Alloys.

Kim, Y H ; Manning, S D

CORPORATE SOURCE: General Dynamics Corp, American Society for Testing and Materials

CONFERENCE: Fracture Mechanics, 14th Symposium, Vol. 1, Theory and Analysis, Los Angeles, Calif., 30 June-2 July 1981 446-462

PUBL: American Society for Testing and Materials, 1916 Race St., Philadelphia, Pa. 19103, 1983

JOURNAL ANNOUNCEMENT: 8401

DOCUMENT TYPE: CONFERENCE PAPER

LANGUAGE: ENGLISH

ABSTRACT: The mechanisms for fatigue crack growth in Al alloys under a chemically aggressive environment is discussed, based on the current understanding of hydrogen embrittlement phenomena. This mechanism is discussed quantitatively in terms of the three-term superposition model proposed by Wei, et al . A diffusion-controlled model, characterizing the cycle-dependent interaction of fatigue loading and environmental attack, is developed, based on the assumption that crack growth enhancement results from microvoid nucleation due to H accumulation at inhomogeneities ahead of

a crack tip. This model is evaluated with limited data on Al 7075-T6. The model accounts for the significant parameters affecting corrosion-fatigue crack growth enhancement. Integration of the model into the superposition scheme is discussed, including the application to predicting crack growth behavior in a corrosive environment for spectrum loading. 29 ref.--AA.

DESCRIPTORS: US wrought alloy 7075-- Corrosion fatigue; Al Zn Mg Cu wrought alloys-- Corrosion fatigue; Corrosion fatigue-- Mathematical models ; Fatigue failure-- Mechanisms

SECTION HEADINGS: 64 (Corrosion)

3.

186678 82-710028

An AGARD-Coordinated Corrosion Fatigue Cooperative Testing Program (CFCTP) and Its Continuation, Aircraft Environment Simulation Fatigue Testing (AESFT).

Wanhill, R J H ; De Luccia, J J

CONFERENCE: Corrosion Fatigue, Cesme, Turkey, 5-10 Apr. 1981 iii, v-viii

PUBL: Advisory Group for Aerospace Research and Development, 92200 Neuilly sur Seine, France, Oct. 1981

JOURNAL ANNOUNCEMENT: 8203

DOCUMENT TYPE: CONFERENCE PAPER

LANGUAGE: ENGLISH

ABSTRACT: The testing program (initiated in 1977) included eight laboratories. A manual specified all technical requirements and test details. The supplement program was to assess current protection systems and help develop new ones. The CFCTP manual is summarized and an overview of the planned aircraft environment simulation fatigue testing facilities is given. The core program included tests in dogbone specimens from a single heat of 3.2 mm bare 7075-T76 sheet, with press-fit Hi-Lok fasteners. Additional alloys tested in individual laboratories, and the tests, are set out. Some specimens were precorroded in aqueous 5% NaCl acidified by SO2 and fatigued in salt fog.--EAA/AF.

DESCRIPTORS: Corrosion fatigue-- Tests; US wrought alloy 7075-- Corrosion tests; Al Zn Mg Cu wrought alloys-- Corrosion tests; Salt spray tests; Environmental testing-- Simulation

SECTION HEADINGS: 71 (Testing and Control)

4.

186637 82-640064

Fracture Mechanics-Based Modeling of the Corrosion Fatigue Process.

Hoeppner, D W ; Mann, D ; Weeks, J

CONFERENCE: Corrosion Fatigue, Cesme, Turkey, 5-10 Apr. 1981 2.1-2.17

PUBL: Advisory Group for Aerospace Research and Development, 92200 Neuilly sur Seine, France, Oct. 1981

REPORT NO.: AGARD Conf. No. 316

JOURNAL ANNOUNCEMENT: 8203

DOCUMENT TYPE: CONFERENCE PAPER

LANGUAGE: ENGLISH

ABSTRACT: Mechanisms related to the formation of micromechanical life prediction models are discussed. The formation of Mode I fatigue cracks from pits is considered; from previous work on 2024, 2124, 7075, the model offers promise of estimation capability. Problems are discussed. Fretting

fatigue is briefly considered (with a reference to 7075-T6). 34 ref.--EAA/AF.
DESCRIPTORS: Corrosion fatigue-- Mathematical models; Fracture mechanics; US wrought alloy 2024-- Corrosion fatigue; US wrought alloy 2124-- Corrosion fatigue; US wrought alloy 7075-- Corrosion fatigue; Al Cu Mg Mn wrought alloys-- Corrosion fatigue; Al Zn Mg Cu wrought alloys-- Corrosion fatigue
SECTION HEADINGS: 64 (Corrosion)

5.

171240 79-610658
Model for Prediction of Fatigue Lives Based Upon a Pitting Corrosion Fatigue Process.
Hoeppner, D W
CONFERENCE: Fatigue Mechanisms, Kansas City, Mo., 22-24 May 1978 841-870
PUBL: American Society for Testing and Materials, 1916 Race St., Philadelphia, Pa. 19103, 1979
JOURNAL ANNOUNCEMENT: 7912
DOCUMENT TYPE: CONFERENCE PAPER
LANGUAGE: ENGLISH
ABSTRACT: The pitting corrosion fatigue process is postulated to be a possible environment/deformation synergism that might explain the initiation of cracking in materials subjected to the combined action of environment and alternating strain. A conceptual model for such a process is presented that involves utilization of an empirical pitting rate curve and a Weibull fit of the appropriate crack growth data. An experimental technique for observing growth of pits under cyclic loading is described for 7075 Al. Some shortcomings of the conceptual model and needs for additional research are discussed.23 refs.--AA.
DESCRIPTORS: US wrought alloy 7075-- Fatigue life; Al Zn Mg Cu wrought alloys-- Fatigue life; Fatigue life-- Forecasting; Pitting (corrosion); Corrosion fatigue
SECTION HEADINGS: 61 (Mechanical Properties)

6.

164872 79-640038
A Quantitative Assessment of the Superposition Model of Corrosion Fatigue.
Trant, P J
JOURNAL: I Mech. E. Conf. Publ., (4), 57-63
PUBL. DATE: 1977
JOURNAL ANNOUNCEMENT: 7902
DOCUMENT TYPE: ARTICLE
LANGUAGE: ENGLISH
ABSTRACT: Electrochemical techniques were applied to the title model. A technique described to determine bare surface reaction rates so that the theoretical propagation rates may be determined and these are then related to the observed corrosion fatigue behavior for an Al 93--Mg 7 alloy and X-65 pipeline steel a Cl--solution. Slip dissolution or H embrittlement of the bare metal at the crack tip may account or have a role in the propagation rate on the bare surface. At a given potential, the propagation rate is controlled by the bare surface reaction rate and the interaction

between the passivation rate, the oxide rupture rate and the solution renewal rate.--CA.
DESCRIPTORS: Corrosion fatigue-- Mathematical models; Al Mg wrought alloys-- Corrosion fatigue; Crack propagation-- Surface condition effects
SECTION HEADINGS: 64 (Corrosion)

7.

1947036 MA Number: 199707-35-1183
Transition from pitting to fatigue crack growth--modeling of corrosion fatigue crack nucleation in a 2024-T3 aluminum alloy.
Chen, G S ; Wan, K -C ; Gao, M ; Wei, R P ; Flournoy, T H
Lehigh University
Switzerland, 1996
Materials Science and Engineering A 219, (1-2), 126-132 30 Nov. 1996
ISSN: 0921-5093
Country of Publication: Switzerland
Journal Announcement: 9707
Document Type: Article
Language: ENGLISH
Abstract: The nucleation of fatigue cracks from corrosion pits was investigated by conducting fatigue experiments on open-hole specimens of a 2024-T3 aluminum (bare) alloy in 0.5 M NaCl solution at room temperature and different load frequencies from 0.1 to 20 Hz. The maximum cyclic stresses applied at the hole ranged from 144 to 288 MPa and the load ratio, R, was 0.1. A specimen subjected to pre-corrosion in the NaCl solution prior to corrosion fatigue was also investigated. Pitting was found to be associated with constituent particles in the hole and pit growth often involved coalescence of individual particle-nucleated pits. Fatigue cracks typically nucleated from one or two of the larger pits, and the size of the pit at which the fatigue crack nucleates is a function of stress level and load frequency. The observations indicate that the nucleation of corrosion fatigue cracks essentially results from a competition between the processes of pitting and crack growth. Pitting predominates in the early stage of the corrosion fatigue process, and is replaced by corrosion fatigue crack growth. Based on these results, two criteria are proposed to describe the transition from pit growth to fatigue crack growth: (1) the stress intensity factor of the equivalent surface crack has to reach the threshold stress intensity factor, Delta K sub th , for fatigue crack growth, assuming that a corrosion pit may be modeled by an equivalent semi-elliptical surface crack, and (2) the time-based corrosion fatigue crack growth rate also exceeds the pit growth rate. Copyright (c) 1997 Elsevier Science S.A. All rights reserved.
Descriptors: Journal Article; Aluminum base alloys-- Corrosion; Pitting (corrosion); Crack propagation
Alloy Index(Identifier): 2024-- AL
Section Headings: 35 (CORROSION)

8.

1939436 MA Number: 199705-31-1911
A micro-mechanics model of corrosion-fatigue crack growth in steels.
de los Rios, E R ; Wu, X D ; Miller, K J
University of Sheffield
UK, 1996

Fatigue and Fracture of Engineering Materials and Structures 19, (11), 1383-1400 1996 ISSN: 8756-758X
Country of Publication: UK
Journal Announcement: 9705
Document Type: Article
Language: ENGLISH
Abstract: Principles of Microstructural Fracture Mechanics (MFM) are used to develop a model for the characterization of environment-assisted short fatigue crack growth. Fatigue cracks are invariably initiated at corrosion pits formed at inclusions, hence the analysis includes stress concentration effects at pits that lead to the propagation of fatigue cracks the rates of which are considered to be proportional to the crack tip plastic displacement. This plasicity is constrained by microstructural barriers which are overcome in a non-aggressive environment at critical crack lengths only when the applied stress is higher than the fatigue limit. However, the superposition of an aggressive environment assists fatigue damage via crack tip dissolution, enhancement of crack tip plastic deformation, the introduction of stress concentrations at pits and a reduction of the strength of the microstructural barrier. These environment effects are manifested in a drastic reduction of the fatigue limit and higher crack propagation rates. The model is compared with fatigue crack propagation data of a BS251A58 steel tested in reversed torsion when submerged in a 0.6M NaCl solution. Graphs. 30 ref.
Descriptors: Journal Article; Fracture mechanics; Pitting (corrosion); Crack propagation; Spring steels-- Mechanical properties
Section Headings: 31 (MECHANICAL PROPERTIES)

9.

1912538 MA Number: 199609-35-1811
Computer simulation of diffusion transport in corrosion fatigue cracks.
van der Wekken, C J
Delft University of Technology
Conference: UK Corrosion and Eurocorr 94. Vol 4, Bournemouth, United Kingdom, 31 Oct.-3 Nov. 1994
Publ: Institute of Materials, 1 Carlton House Terrace, London, SW1Y 5DB, UK, 1994
29-39 1994
Country of Publication: UK
Journal Announcement: 9609
Document Type: Preprint
Language: ENGLISH
Abstract: The paths followed by a large number of solute particles during cyclic laminar flow resulting from a sinusoidal displacement of the walls of a triangular corrosion fatigue crack have been calculated, simulating the effect of diffusion by allowing the solute particles at arbitrary moments in the fatigue cycle to jump randomly in the positive or negative direction perpendicular to the crack walls. The value of the effective solute diffusion coefficient D sub eff was calculated from the displacements of the particles after a complete fatigue cycle. By varying the average jumping frequency and the magnitude of the jumps, D sub eff could be determined as a function of the characteristic dimensionless parameter G, and the limits of the range of G values where flow-enhanced diffusion plays a significant role in solute transport have been established. Graphs. 3 ref.

Descriptors: Preprint; Corrosion fatigue; Diffusion; Fatigue failure; Computer simulation
Section Headings: 35 (CORROSION)

10.

1809680 MA Number: 199401-31-0119
Corrosion Deformation Interaction in Corrosion Fatigue and High Temperature Fatigue. Model Experiments With Bicrystals.
Vehoff, H
Max-Planck-Institut fur Eisenforschung
Conference: Corrosion--Deformation Interactions, Fontainebleau, France, 5-7 Oct. 1992
Publ: Les Editions de Physique, Avenue du Hoggar, Zone Industrielle de Courtaboeuf, B.P. 112, F-91944 Les Ulis Cedex A, France, 1993
671-683
Country of Publication: France
Journal Announcement: 9401
Document Type: Conference Paper
Language: ENGLISH
Abstract: The nucleation and growth of fatigue cracks in aqueous environments and in air at high temperature were examined in detail on bicrystals made from ferritic steels. The influence of orientation, segregation, potential and deformation rate was measured systematically. In aqueous environments, cracks nucleated preferentially at boundaries which concentrated slip parallel to the boundary and facilitated film rupture. Crack initiation and crack growth could be explained with the slip step dissolution model. The same model was used to model the influence of oxidation on intergranular fatigue crack growth at high temperatures. At medium deformation rates, intergranular cracks were observed. If, however, the cycle time was further decreased, the films grew laterally together and transgranular crack growth was found. The experimental results can be explained by similar models when it is guaranteed that film rupture is the dominant damage mechanism at high temperature or in aqueous solutions. Graphs; Photomicrographs. 17 ref.
Descriptors: Conference Paper; Bicrystals-- Mechanical properties; Ferrous alloys-- Mechanical properties; Corrosion fatigue; Crack initiation ; Crack propagation; Slip; Dissolution; Intergranular fracture; Stress corrosion cracking
Alloy Index(Identifier): Fe-2.91Si, Fe-2.89Si, Fe-2.78Si, Fe-2.72Si, Fe-2.9Si-- FE
Section Headings: 31 (MECHANICAL PROPERTIES); 35 (CORROSION)

11.

1793121 MA Number: 199308-31-2930
A Mechanistically Based Approach to Probability Modeling for Corrosion Fatigue Crack Growth.
Harlow, D G ; Wei, R P
Lehigh University
Engineering Fracture Mechanics 45, (1), 79-88 May 1993 ISSN: 0013-7944
Country of Publication: UK
Journal Announcement: 9308
Document Type: Article

Language: ENGLISH

Abstract: An approach and methodology for developing a probability model for life prediction and its utility are demonstrated. The goal of this probabilistic approach is to make stochastically tight estimates of life for conditions that are beyond the range used in typical supporting data. Probability models, vs. statistically based models, are used to describe the influences of fundamental variables through mechanistically based models of the failure processes. The efficacy of a probabilistic model, therefore, depends crucially upon the availability and quality of a mechanistically based model. The approach and methodology is illustrated through the use of a simplified model for reaction controlled corrosion fatigue crack growth for ferrous alloys inaqueous environments. The stochastic contributions from material properties and from the effects of environmental (electrochemical and thermal) and loading variables are assessed. An X70 steel is tested. Graphs. 15 ref.

Descriptors: Journal Article; Carbon manganese steels-- Mechanical properties; Corrosion fatigue; Fatigue failure; Crack propagation; Mathematical models

Alloy Index(Identifier): X770-- SCMN

Section Headings: 31 (MECHANICAL PROPERTIES)

12.

1779896 MA Number: 199304-35-0709

Corrosion Fatigue Crack Growth of Steels in Aqueous Solutions. II. Modeling the Effects of Delta K.

Thomas, J P ; Wei, R P

Lehigh University

Materials Science and Engineering A A159, (2), 223-229 30 Dec. 1992

ISSN: 0921-5093

Country of Publication: Switzerland

Journal Announcement: 9304

Document Type: Article

Language: ENGLISH

Abstract: The objective was to model the effect of the stress intensity factor range Delta K on the enhancement of the crack growth rate (ECGR) for medium to high strength steels in aqueous environments. Experimental results demonstrated that Delta K affected both the magnitude and time response of the ECGR. Tests on an HY-130 steel in de-aerated 3.5% NaCl solution showed that the magnitude of the ECGR proportional to K exp 3 sub max and that the time response of the ECGR proportional to Delta K exp --2.3 . A model for the ECGR, as a function of K sub max and saturation charge transfer level, was developed using the heuristic modeling framework developed in Part K (J.P. Thomas and R.P. Wei, Mater. Sci. Eng., A159(1992) 205-221) and a stress-assisted diffusion model taken from the literature. The model accounted for K in terms of its effect on the hydrogen distribution in the crack tip region and its effect on the surface kinetics. Graphs. 13 ref.

Descriptors: Journal Article; Nickel chromium molybdenum steels-- Corrosion; Crack propagation-- Corrosion effects; Corrosion fatigue; Corrosion mechanisms; Sodium chloride-- Environment; Mathematical models

Alloy Index(Identifier): HY130-- SANCM

Section Headings: 35 (CORROSION)

13.

1779895 MA Number: 199304-35-0708

Corrosion Fatigue Crack Growth of Steels in Aqueous Solutions. I. Experimental Results and Modeling the Effects of Frequency and Temperature.

Thomas, J P ; Wei, R P

Lehigh University

Materials Science and Engineering A A159, (2), 205-221 30 Dec. 1992

ISSN: 0921-5093

Country of Publication: Switzerland

Journal Announcement: 9304

Document Type: Article

Language: ENGLISH

Abstract: The objective was to develop a model for the effects of stress intensity factor range Omega K, cyclic loading frequency f, and temperature T on the enhancement of the crack growth rate (ECGR) for medium to high strength steels in aqueous environments. An experimental study was performed to determine the crack growth (CG) response of a HY-130 steel in de-aerated 3.5% NaCl solution, as a function of Delta K, f, and T. The results show that the crack growth rate CGR) exhibited an exponential-like dependence on 1/f, with saturation occurring as the frequency decreased. Increases in temperature shifted the CG response curve to higher frequencies, with an apparent activation energy of approx 30 kJ mol exp --1 , while increases in Delta K increased the saturation CGR and shifted the data to lower frequencies. A heuristic model was developed to link the chemical and mechanical processes occurring at the crack tip. ECGR was assumed to result from hydrogen embrittlement and was controlled by the rate of the electrochemical surface reactions. The CG response was related to the charge transferred during the transient reactions, which explained the frequency and temperature dependence in terms of reaction kinetics and time. Graphs. 33 ref.

Descriptors: Journal Article; Nickel chromium molybdenum steels-- Corrosion; Crack propagation-- Corrosion effects; Corrosion fatigue; Sodium chloride-- Environment; Mathematical models

Alloy Index(Identifier): HY130-- SANCM

Section Headings: 35 (CORROSION)

14.

1769006 MA Number: 199301-35-0166

A Simulation of Corrosion Fatigue Life Distribution in Low Alloy Steel.

Nakajima, M ; Kunieda, H ; Tokaji, K

Toyota College of Technology

Conference: Fatigue Design 1992. Vol. 2, Helsinki, Finland, 19-22 May 1992

Publ: Technical Research Centre of Finland, Vuorimiehentie 5, P.O. Box 42, SF-02151 Espoo, Finland, 1992

137-151

Country of Publication: Finland

Report No.: VTT 131

Journal Announcement: 9301

Document Type: Conference Paper

Language: ENGLISH

Abstract: A Monte Carlo simulation of corrosion fatigue life distributions has been conducted on a low alloy steel, SNCM439, by assuming that the scatter of fatigue life resulted from the variation in the growth characteristics of corrosion pits and fatigue cracks. The parameters used

in the simulation were obtained experimentally. The results showed that the experimental distributions were expressed satisfactorily by the simulation in which the parameters obtained from fatigue tests at the same stress were used. Therefore, it is concluded that corrosion fatigue life distribution can be predicted by a Monte Carlo simulation taking account of the statistical properties in the growth processes of corrosion pits and fatigue cracks. Graphs. 7 ref.

Descriptors: Conference Paper; Nickel chromium molybdenum steels-- Corrosion; Corrosion fatigue; Fatigue life; Computer simulation; Sodium chloride-- Environment; Pitting (corrosion)

Alloy Index(Identifier): SNCM439-- SANCM

Section Headings: 35 (CORROSION)

15.

1693735 MA Number: 91-350520

Modeling of Corrosion Fatigue Crack Initiation Under Passive Electrochemical Conditions.

Daeubler, M A ; Warren, G W ; Bernstein, I M ; Thompson, A W

Carnegie-Mellon University

Metallurgical Transactions A 22A, (2), 521-529 Feb. 1991 ISSN: 0360-2133

Journal Announcement: 9103

Document Type: ARTICLE

Language: ENGLISH

Abstract: A combined mechanical/electrochemical model has been developed which successfully predicts the corrosion fatigue initiation behavior of an Fe-base superalloy A-286 using readily measurable electrochemical and mechanical properties. In particular, the model uses the current decay curve, the initial or bare metal corrosion rate, and the critical slip step height, a parameter associated with the transition from an intense slip band to an incipient crack. The exponential parameter, alpha , used to fit the early (short time) portion of the current decay curve has been found to scale with the fatigue crack initiation time, suggesting that alpha could be used as a valuable screening aid to assess the corrosion fatigue susceptibility of any alloy under passive electrochemical conditions. The model permits accurate prediction of both the shape and magnitude of fatigue life (S--N) curves. The limitations and theoretical implications of the approach of this model are also discussed. Graphs. 40 ref.--AA

Descriptors: Ferrous alloys-- Corrosion; Superalloys-- Corrosion; Corrosion fatigue; Fatigue life; Crack initiation; Electrochemistry

Alloy Index(Identifier): A286-- FE, SP

Section Headings: 35 (CORROSION)

16.

1600587 MA Number: 89-350034

Various Electrochemical Measurements in a Simulated Corrosion Fatigue Crack.

Charles, E A ; Congleton, J ; Parkins, R N

University of Newcastle upon Tyne

Corrosion 44, (9), 599-605 Sept. 1988 ISSN: 0010-9312

Journal Announcement: 8901

Document Type: ARTICLE

Language: ENGLISH

Abstract: Measurements of potential, current, pH, and chloride ion concentration were made along a simulated corrosion fatigue crack for HY80 (UNS K31820) steel in seawater. The simulated crack yields results comparable with those from real cracks and allows predictions of potential gradients to be made. The results show that movement of the crevice sides to promote pumping does not cause significant solution refreshment within the enclave at frequencies of 0.1 and 0.02 Hz, but flow across the mouth does alter the solution chemistry. These results have been strengthened by diffusion experiments in the crevice. No detectable chloride ion concentration gradients were found in the enclave across the potential range examined. 11 ref.--AA

Descriptors: Nickel chromium molybdenum steels-- Corrosion; Corrosion fatigue; Fatigue (materials); Sea water-- Environment; Crevice corrosion

Alloy Index(Identifier): HY80-- SANCM

Section Headings: 35 (CORROSION)

17.

1540920 MA Number: 87-351821

A Brief Review of Corrosion--Fatigue Phenomena in Simulated Pressurized Water-Reactor Environments.

Bulloch, J H

J. S. Afr. Inst. Min. Metall. 87, (2), 29-39 Feb. 1987 ISSN: 0038-223X

Journal Announcement: 8708

Document Type: ARTICLE

Language: ENGLISH

Abstract: A short review is given of the effects of corrosion fatigue on the low alloy steel materials used in pressurized water-reactor vessels. Selected topics such as testing procedures, test data, and mechanisms in simulated environments are discussed. The main fact that emerges is that most of the data on the growth of fatigue cracks reside below the ASME X1 1980 High-R "Wet" design-code lines, i.e. they fall within that specification. Finally, some recent advances in the understanding of the corrosion--fatigue behaviour of such materials in pressurized water reactors are highlighted. 26 ref.--AA

Descriptors: Low alloy steels-- Corrosion; Corrosion fatigue; Pressurized water reactors-- Materials selection

Alloy Index(Identifier): A533B, A508-- SAL

Section Headings: 35 (CORROSION)

18.

1522137 MA Number: 87-340178

Mathematical Modelling of the Electrochemistry in Corrosion Fatigue Cracks. II. The Influence of the Bicarbonate/Carbonate Reactions of Sea Water on Crack Electrochemistry for Cathodically Protected Structural Steels.

Turnbull, A ; Ferriss, D H

Conference: Modeling Environmental Effects on Crack Growth Processes, Toronto, Canada, 13-17 Oct. 1985

Publ: The Metallurgical Society/AIME, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, 1986

3-39

Journal Announcement: 8703

Document Type: BOOK
Language: ENGLISH
Abstract: A mathematical model was developed to describe the mass transport and electrochemical conditions in a corrosion fatigue crack in a steel (50D HSLA) cathodically protected in sea water. Mass transport by advection, diffusion and ion migration was considered and the principal electrochemical reaction was taken to be reduction of water. To simulate the buffering action of sea water the equilibrium between bicarbonate and carbonate ions was included and the deposition of calcium carbonate on the crack walls was taken into account. The effects on crack tip p H and potential of varying external potential, Delta K (range of the stress intensity factor), R value (minimum load/maximum load), crack depth and frequency were investigated and it was concluded that the effectiveness of the buffering reaction was controlled by the rate of replenishment of bicarbonate ion in the crack. Compared to sodium chloride solutions, the p H at the crack tip was lower although still considerably alkaline, p H > 10, for potentials <= --800 mV (SCE). The potential drop in the crack was greater in the sea water environment than in the sodium chloride environment. Estimates of crack-tip reaction rates in simulated crack environments suggest that at sufficiently negative potentials generation of hydrogen atoms on the external surface will control crack growth rates at long times. Using experimental measurements of crack tip p H and potential, bulk charging may become dominant at potential < approx --1000 mV (SCE). The significance of bulk charging is likely to be enhanced at low R values and for deep cracks for which the potential drop is greatest. 27 ref.--AA
Descriptors: High strength low alloy steels-- Corrosion; Corrosion fatigue; Cracking (fracturing)-- Environmental effects; Sea water-- Environment; Cathodic protection; Mass transfer
Alloy Index(Identifier): 50D-- SALHS
Section Headings: 34 (CHEMICAL AND ELECTROCHEMICAL PROPERTIES)

19.

1521565 MA Number: 87-311159
Modeling of Corrosion Fatigue Pre-Crack Initiation Processes.
Garcia, C ; Duquette, D J
Conference: Modeling Environmental Effects on Crack Growth Processes, Toronto, Canada, 13-17 Oct. 1985
Publ: The Metallurgical Society/AIME, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, 1986
343-354
Journal Announcement: 8703
Document Type: BOOK
Language: ENGLISH
Abstract: Load controlled and strain controlled cyclic deformation experiments have been performed on Ni monocrystals and polycrystals to evaluate a proposed model of slip band/environment interactions which lead to corrosion fatigue crack initiation. The experiments were conducted in 1N H sub 2 SO sub 4 at the free corrosion potential and at a potential which corresponded to the critical or maximum current density in the active/passive transition. The results of the experiments have verified that active corrosion of a cyclically deformed metal surface resulted in enhanced persistent slip band (PSB) formation and accordingly, enhanced cyclic deformation of the metal, at least for low to moderate strain ranges. The results can be explained by a model which suggests that

corrosion establishes instabilities on the metal surface which initiate and propagate PSB. These PSBs are, in turn, preferentially corroded, leading to further deformation in the bands and, accordingly, early crack initiation. 10 ref.--AA

Descriptors: Nickel-- Mechanical properties; Single crystals-- Mechanical properties; Polycrystals-- Mechanical properties; Corrosion fatigue-- Environmental effects; Crack initiation-- Environmental effects; Sulfuric acid-- Environment; Copper-- Mechanical properties

Section Headings: 31 (MECHANICAL PROPERTIES)

20.

918709 MA Number: 85-310443

Oxygen Inhibition Model of the Chemical Crack Size Effect in Corrosion Fatigue.

Gangloff, R P

Conference: Embrittlement by the Localized Crack Environment, Philadelphia, Pa., U.S.A., 4-5 Oct. 1983

Publ: The Metallurgical Society/AIME, 420 Commonwealth Dr., Warrendale, Pa. 15086, U.S.A., 1984

265-290

Journal Announcement: 8502

Document Type: BOOK

Language: ENGLISH

Abstract: The unexpectedly rapid growth kinetics of small corrosion fatigue cracks in high-strength 4130 steel exposed to aqueous NaCl are explained based on crack geometry dependent solution transport and reaction. The chemical driving force for cracking is modeled based on anodic dissolution, cation hydrolysis and cathodic reduction to produce embrittling hydrogen within the crack. The H concentration and the resultant rate of brittle crack advance is controlled by convective oxygen supply and reaction consuming H ions for the pulsating fatigue crack. Based on a perfect mixing approximation, O inhibition depends exponentially on the crack surface area to solution volume ratio, proportional to reciprocal crack mouth opening displacement. A short crack is characterized uniquely by a small mouth opening, a large surface area to occluded solution volume ratio, limited O inhibition of H production and rapid corrosion fatigue crack propagation. Quantitatively, a linear relationship betwen the logarithm of the corrosion fatigue crack growth rate and reciprocal mouth opening is predicted and confirmed by data for a range of crack sizes, geometries and applied stresses. Reduced rates of corrosion fatigue correlate with an increased proportion of brittle transgranular cracking, replacing intergranular separation and described by crack mouth displacement. Fatigue experiments in deoxygenated NaCl provide limited, but inconclusive, support for the O inhibition hypothesis. 46 ref.--AA

Descriptors: Chromium molybdenum steels-- Mechanical properties; Crack propagation; Corrosion fatigue; Sodium chloride-- Environment; Hydrogen embrittlement; Fatigue failure; Stress intensity

Alloy Index(Identifier): 4130-- SACM

Section Headings: 31 (MECHANICAL PROPERTIES)

21.

918708 MA Number: 85-310442

Corrosion Fatigue and Modeling.

Wei, R P ; Shim, G ; Tanaka, K
Conference: Embrittlement by the Localized Crack Environment, Philadelphia, Pa., U.S.A., 4-5 Oct. 1983
Publ: The Metallurgical Society/AIME, 420 Commonwealth Dr., Warrendale, Pa. 15086, U.S.A., 1984
243-263
Journal Announcement: 8502
Document Type: BOOK
Language: ENGLISH
Abstract: Corrosion fatigue, or environmentally assisted fatigue crack growth, is a multifaceted problem that involves complex interactions of loading, environmental and metallurgical variables. Modeling of cracking response of Al-base alloys, Cr--Mo steels and high-strength steels in gaseous and aqueous environments is reviewed and considered in relation to the rate-controlling process and crack tip environment. 39 ref.--AA
Descriptors: Aluminum base alloys--.Mechanical properties; High strength steels-- Mechanical properties; Chromium molybdenum steels-- Mechanical properties; Corrosion fatigue; Fatigue failure; Crack propagation; Mathematical models; Reviews
Section Headings: 31 (MECHANICAL PROPERTIES)

22.

853612 MA Number: 83-351485
Mathematical Model of Corrosion Fatigue. (Translation).
Azhogin, F F ; Goryachko, Yu S ; Ozhiganov, Yu G
Sov. Mater. Sci. 18, (4), 350-355 July-Aug. 1982 ISSN: 0038-5565
Journal Announcement: 8307
Document Type: ARTICLE
Language: ENGLISH
Abstract: See Met. A. , 8303-35-0414.
Descriptors: Steels-- Corrosion; Corrosion fatigue; Mathematical models
Section Headings: 35 (CORROSION)

668941 MA Number: 79-311630
Investigation and Modeling of the Kinetics of the Development of Corrosion-Fatigue Cracks. (Translation).
Vasserman, N N ; Merkushev, V A ; Nemanov, M S
Sov. Mater. Sci. 13, (3), 235-239 May-June 1977
Journal Announcement: 7907
Document Type: ARTICLE
Language: ENGLISH
Abstract: See Met. A., 7712-31 3678.
Descriptors: Nickel chromium molybdenum steels-- Corrosion; Corrosion fatigue; Crack propagation; Fatigue failure
Alloy Index(Identifier): 35KhN1M-- SANCM
Section Headings: 31 (MECHANICAL PROPERTIES)

23.

04053596 E.I. No: EIP95012539603
Title: Reliability model for fatigue and corrosion of hydraulic steel structures
Author: Padula, Joseph; Chasten, Cameron; Mlakar, Paul; Mosher, Reed
Corporate Source: U.S. Army Corps of Engineers Waterways Experiment

Station, Vicksburg, MS, USA
Conference Title: Proceedings of the 3rd Materials Engineering Conference
Conference Location: San Diego, CA, USA Conference Date: 19941113-19941116
Sponsor: ASCE
E.I. Conference No.: 42249
Source: Infrastructute: New Materials and Methods of Repair Proceedings of the Materials Engineering Conference 804 Oct 1994. ASCE, New York, NY, USA. p 1217-1224
Publication Year: 1994
CODEN: 001695
Language: English
Document Type: CA; (Conference Article) Treatment: A; (Applications); T ; (Theoretical)
Journal Announcement: 9504W1
Abstract: A generalized procedure for assessing the reliability of structural steel components with corrosion degradation and fatigue is presented. The reliability analysis is based on a Taylor Series- Finite Difference approximation which provides a computationally expedient means of estimating the reliability index and reliability of a structural member. Random variables incorporated into the procedure include corrosion rate, fatigue life, loading, material strength and uncertainty due to modeling assumptions. The procedure is generally applicable and is intended to provide practicing engineers with a means for assessing the reliability of existing hydraulic steel structures. (Author abstract) 10 Refs.
Descriptors: *Steel structures; Hydraulic structures; Fatigue of materials; Steel corrosion; Mathematical models; Finite difference method; Approximation theory; Structural members; Structural analysis; Reliability
Identifiers: Taylor series finite difference approximation; Reliability index
Classification Codes:
408.2 (Structural Members & Shapes); 545.3 (Steel); 441.3 (Related Hydraulic Structures); 539.1 (Metals Corrosion); 921.6 (Numerical Methods)
408 (Structural Design); 545 (Iron & Steel); 441 (Dams & Reservoirs); 421 (Materials Properties); 539 (Metals Corrosion & Protection); 921 (Applied Mathematics)
54 (METAL GROUPS); 44 (WATER & WATERWORKS ENGINEERING); 42 (MATERIALS PROPERTIES & TESTING); 53 (METALLURGICAL ENGINEERING); 92 (ENGINEERING MATHEMATICS)

24.

03425577 E.I. Monthly No: EI9205059392
Title: Computer simulation of corrosion fatigue process considering stress relaxation due to initiation and propagation of multiple cracks.
Author: Ishihara, Sotomi; Shiozawa, Kazuaki; Miyao, Kazyu; Miwa, Hiroshi
Corporate Source: Toyama Univ, Toyama, Jpn
Source: JSME International Journal, Series 1: Solid Mechanics, Strength of Materials v 35 n 1 Jan 1992 p 78-83
Publication Year: 1992
CODEN: JSSMEH ISSN: 0914-8809
Language: English
Document Type: JA; (Journal Article) Treatment: T; (Theoretical); X; (Experimental)
Journal Announcement: 9205

Abstract: In order to investigate stress relaxation behavior at the specimen surface during the corrosion fatigue process caused by the initiation and propagation of many cracks, rotating bending fatigue tests were carried out in sodium chloride aqueous solution using specimens of 6 and 12 mm diameters. Stress amplitude decreases of about 25 approximately 50% were observed during the corrosion fatigue process performed at low stress amplitude. This stress relaxation behavior is well evaluated by calculating the compliance increase of the specimen. Computer simulations of the corrosion fatigue process of the unnotched specimens were conducted. The results showed good agreement with the experimental results. In the simulations, probabilistic crack initiation behavior during the corrosion fatigue process, the stress relaxation effect at the cracked parts and crack coalescences among many distributed cracks are taken into consideration. (Author abstract) 5 Refs.
Descriptors: *CORROSION--*Corrosion Fatigue; COMPUTER SIMULATION; RELAXATION PROCESSES--Stresses; STEEL TESTING--Fatigue; STEEL--Crack Propagation
Identifiers: STRESS RELAXATION
Classification Codes:
539 (Metals Corrosion & Protection); 421 (Materials Properties); 545 (Iron & Steel); 723 (Computer Software)
53 (METALLURGICAL ENGINEERING); 42 (MATERIALS PROPERTIES & TESTING); 54 (METAL GROUPS); 72 (COMPUTERS & DATA PROCESSING)

25.

5513874 INSPEC Abstract Number: A9707-8140N-083
Title: AFM measurements and micromechanics modeling of corrosion fatigue
Author(s): Gerberich, W.W.; Harvey, S.E.; Marsh, P.G.; Kriese, M.D.; Kramer, D.E.; Geng, W.; Strojny, A.; Hoehn, J.W.
Author Affiliation: Dept. of Chem. Eng. & Mater. Sci., Minnesota Univ., Minneapolis, MN, USA
Conference Title: New Techniques for Characterizing Corrosion and Stress Corrosion. Proceedings p.129-39
Editor(s): Jones, R.H.; Baer, D.R.
Publisher: TMS - Miner. Metals & Mater. Soc, Warrendale, PA, USA
Publication Date: 1996 Country of Publication: USA vii+329 pp.
ISBN: 0 87339 325 2 Material Identity Number: XX96-03443
Conference Title: Proceedings of Materials Week '95 New Techniques for Characterizing Corrosion and Stress Corrosion
Conference Sponsor: TMS - Miner. Metals & Mater. Soc
Conference Date: 29 Oct.-2 Nov. 1995 Conference Location: Cleveland, OH, USA
Language: English Document Type: Conference Paper (PA)
Treatment: Experimental (X)
Abstract: If one can model both the onset of crack growth in an environment and the surface damage leading to that event, corrosion fatigue crack nucleation should be predictable. For the former we use a threshold criterion based upon hydrogen embrittlement and for the latter, a damage accumulation rate based upon atomic force microscopy (AFM). Threshold modeling follows from some dislocation shielding approaches that have proved to be successful for the prediction of brittle fracture. The environmental concept is that either gaseous hydrogen or that produced in a corrosion reaction can lower the Griffith energy which can be shown to control the failure criterion, even where large plasticity is involved. The

nucleation concept is that if you can model both surface plasticity with regard to damage accumulation to the point of producing crack-like intrusions and can model the threshold criterion for those intrusions leading to a propagating crack, a good portion of a working corrosion fatigue model is available. This is discussed and compared to corrosion fatigue observations in both HSLA steel and commercially pure titanium. (15 Refs)

Descriptors: alloy steel; atomic force microscopy; brittle fracture; corrosion fatigue; crack-edge stress field analysis; dislocation interactions; fatigue cracks; hydrogen embrittlement; modelling; nucleation ; titanium

Identifiers: micromechanics modeling; commercially pure Ti; crack growth; surface damage; corrosion fatigue crack nucleation; threshold criterion; H embrittlement; damage accumulation rate; atomic force microscopy; dislocation shielding; brittle fracture; gaseous H/sub 2/; corrosion reaction; Griffith energy; failure criterion; nucleation concept; surface plasticity; crack-like intrusions; propagating crack; working corrosion fatigue model; HSLA steel; Ti; H/sub 2/

Class Codes: A8140N (Fatigue, embrittlement, and fracture); A6220M (Fatigue, brittleness, fracture, and cracks); A8160B (Surface treatment and degradation of metals and alloys); A6820 (Solid surface structure)

Chemical Indexing:

Ti sur - Ti el (Elements - 1)

Fe sur - C sur - Fe ss - C ss (Elements - 2)

H2 el - H el (Elements - 1)

26.

5040647 INSPEC Abstract Number: A9519-8160B-094

Title: Computation model of corrosion-fatigue crack growth in thin metallic plates

Author(s): Nykyforchyn, H.M.; Terlets'ka, Z.O.

Author Affiliation: Karpenko Physicomech. Inst., Acad. of Sci., L'viv, Ukraine

Journal: Fiziko-Khimicheskaya Mekhanika Materialov vol.30, no.1 p. 30-4

Publication Date: Jan.-Feb. 1994 Country of Publication: Ukraine

CODEN: FKMMAJ ISSN: 0430-6252

Translated in: Materials Science vol.30, no.1 p.25-30

Publication Date: Jan.-Feb. 1994 Country of Publication: USA

CODEN: MSCIEQ ISSN: 1068-820X

U.S. Copyright Clearance Center Code: 1068-820X/94/3001-0025$12.50

Language: English Document Type: Journal Paper (JP)

Treatment: Theoretical (T)

Abstract: A computation model of corrosion-fatigue crack growth in thin metallic plates is suggested based on well-known theoretical concepts of fatigue and corrosion fracture and some assumptions. A physicochemical model of this process is constructed, and mathematical relations that describe the kinetics of crack propagation are established. The model agrees with well-known experimental data. (10 Refs)

Descriptors: corrosion fatigue; fatigue cracks; metals; reaction kinetics

Identifiers: corrosion-fatigue crack growth; thin metallic plates; computation model; theoretical concepts; physicochemical model; kinetics

Class Codes: A8160B (Surface treatment and degradation of metals and

alloys); A6220M (Fatigue, brittleness, fracture, and cracks)

27.

03533122 INSPEC Abstract Number: A90015736
Title: Several models to predict the low cyclic corrosion fatigue life
Author(s): Jiang Zuguo
Author Affiliation: China Flight Test Res. Center, Xi'an, Shaanxi, China
Conference Title: Advances in Fracture Research. Proceedings of the 7th International Conference on Fracture (ICF7) p.1465-70 vol.2
Editor(s): Salama, K.; Ravi-Chandar, K.; Taplin, D.M.R.; Rao, P.R.
Publisher: Pergamon, Oxford, UK
Publication Date: 1989 Country of Publication: UK 5 vol. xxxix+3581 pp.
ISBN: 0 08 034343 0
Conference Sponsor: Int. Congress on Fracture
Conference Date: 20-24 March 1989 Conference Location: Houston, TX, USA
Language: English Document Type: Conference Paper (PA)
Treatment: Theoretical (T)
Abstract: Two methods have been developed to estimate the failure probability of spherical tanks. They have been compared with Monte Carlo simulation and Hasofer and Lind's reliability index method. (3 Refs)
Descriptors: corrosion fatigue; crack-edge stress field analysis; Monte Carlo methods; probability
Identifiers: crack opening displacement; low cyclic corrosion fatigue life; failure probability; Monte Carlo simulation; Hasofer and Lind's reliability index method
Class Codes: A8140N (Fatigue, embrittlement, and fracture); A6220M (Fatigue, brittleness, fracture, and cracks); A8160 (Corrosion, oxidation, etching, and other surface treatments); A4630N (Fracture mechanics, fatigue, and cracks); A0250 (Probability theory, stochastic processes, and statistics)

28.

01940900 INSPEC Abstract Number: A82105387
Title: Theoretical modelling of the electrochemistry in a corrosion fatigue crack - Numerical solution of time-dependent mass conservation equations involving advection, diffusion and ion-migration
Author(s): Ferriss, D.H.; Turnbull, A.
Issued by: Nat. Phys. Lab., Teddington, UK
Publication Date: June 1982 Country of Publication: UK 21 pp.
Report Number: NPL-DMA(A) 44
Language: English Document Type: Report (RP)
Treatment: Theoretical (T)
Abstract: A mathematical model has been developed to describe the solution composition and electrode potential in a corrosion fatigue crack in a steel cathodically protected in 3.5% NaCl. The model consists of continuity and transport equations for four chemical species within the crack together with an electroneutrality equation. Mass transport by advection (induced by the cyclic displacement of the crack walls), diffusion and ion-migration are considered. The electrochemical reaction is reduction of water on the walls and tip of the crack. The mathematical

equations constitute a system of nonlinear parabolic partial-differential equations. A numerical method is developed for their solution and is described in detail. The numerical technique is designed so that additional reactions can be introduced into the model should this be desired at a later stage of development. An example of the application of the model is described. (11 Refs)

Descriptors: steel; stress corrosion cracking

Identifiers: cathodic protection; numerical solution; theoretical modelling; time dependent mass conservation equations; electrochemistry; advection; diffusion; ion migration; mathematical model; electrode potential; corrosion fatigue crack; steel; NaCl; transport equations; electroneutrality equation; nonlinear parabolic partial-differential equations

Class Codes: A6220M (Fatigue, brittleness, fracture, and cracks); A8160B (Metals and alloys)

29.

02179692 N95-14483

Modeling time-dependent corrosion fatigue crack propagation in 7000 series aluminum alloys

MASON, MARK E.; GANGLOFF, RICHARD P.

Virginia Univ., Charlottesville, VA. Center for Electrochemical Science and Engineering.

CORPORATE CODE: V3127208

In NASA. Langley Research Center, FAA/NASA International Symposium on Advanced Structural Integrity Methods for Airframe Durability and Damage Tolerance p 441-462 (SEE N95-14453 03-39)

Sep. 1994

CONTRACT NO.: NAG1-745

LANGUAGE: English

COUNTRY OF ORIGIN: United States COUNTRY OF PUBLICATION: United States

DOCUMENT TYPE: CONFERENCE PAPER

DOCUMENTS AVAILABLE FROM AIAA Technical Library

OTHER AVAILABILITY: CASI HC A03/MF A04

JOURNAL ANNOUNCEMENT: STAR9503

Stress corrosion cracking and corrosion fatigue experiments were conducted with the susceptible S-L orientation of AA7075-T651, immersed in acidified and inhibited NaCl solution, to provide a basis for incorporating environmental effects into fatigue crack propagation life prediction codes such as NASA FLAGRO. This environment enhances da/dN by five to ten-fold compared to fatigue in moist air. Time-based crack growth rates from quasi-static load experiments are an order of magnitude too small for accurate linear superposition prediction of da/dN for loading frequencies above 0.001 Hz. Alternate methods of establishing da/dt, based on rising-load or ripple-load-enhanced crack tip strain rate, do not increase da/dt and do not improve linear superposition. Corrosion fatigue is characterized by two regimes of frequency dependence; da/dN is proportional to f(exp -1) below 0.001 Hz and to F(exp 0) to F(exp -0.1) for higher frequencies. Da/dN increases mildly both with increasing hold-time at K(sub max) and with increasing rise-time for a range of loading waveforms. The mild time-dependence is due to cycle-time-dependent corrosion fatigue growth. This behavior is identical for S-L nd L-T crack orientations. The frequency response of environmental fatigue in several 7000 series alloys is variable and depends on undefined compositional or microstructural

variables. Speculative explanations are based on the effect of Mg on occluded crack chemistry and embritting hydrogen uptake, or on variable hydrogen diffusion in the crack tip process zone. Cracking in the 7075/NaCl system is adequately described for life prediction by linear superposition for prolonged load-cycle periods, and by a time-dependent upper bound relationship between da/dN and delta K for moderate loading times. (Author)

DESCRIPTORS: *ALUMINUM ALLOYS; *CORROSION; *CRACK PROPAGATION; *CRACK TIPS; *FATIGUE (MATERIALS); *FATIGUE TESTS; *SALT SPRAY TESTS; *STRESS CORROSION CRACKING; *STRUCTURAL ANALYSIS; *TIME DEPENDENCE; DIFFUSION; ENVIRONMENT EFFECTS; FREQUENCY RESPONSE; HYDROGEN; LOADS (FORCES); MICROSTRUCTURE; PREDICTIONS; STRAIN RATE

SUBJECT CLASSIFICATION: 7526 Metallic Materials (1975-)

30.

01902687 N90-24404

Mechanistic modeling of corrosion fatigue crack growth of steels in aqueous solutions

Ph.D. Thesis

THOMAS, JAMES PAUL

Lehigh Univ., Bethlehem, PA.

CORPORATE CODE: LK410779

1989 240P.

LANGUAGE: English

COUNTRY OF ORIGIN: United States COUNTRY OF PUBLICATION: United States

DOCUMENT TYPE: THESIS

DOCUMENTS AVAILABLE FROM AIAA Technical Library

OTHER AVAILABILITY: Univ. Microfilms Order No. DA9008094

JOURNAL ANNOUNCEMENT: STAR9018

The primary objective was to develop a model for the effects of the range of stress intensity factor (delta K), cyclic loading frequency (f), and temperature (T) on the enhancement of the crack growth rate (ECGR) for medium to high strength steels in aqueous environments. Also, an understanding was sought for the role played by delta K, f, and T on the chemical and mechanical processes leading to an ECGR. An experimental study was performed to determine the crack growth (CG) response of a HY-130 steel in de-aerated 3.5 percent NaCl solution, as a function of delta K, f, and T. Tests were performed at the delta K levels: 30, 21, and 14.5 MPa square root of m, with R = 0.25; four temperatures, from 273 to 345 K; and eight frequencies, from 0.05 to 10 Hz; and polarization at -800 mV (SCE). Reference rate tests were performed in dehumidified ultra high purity argon gas. The crack growth rate (CGR) exhibited an exponential-like dependence on 1/f, with saturation occurring as the frequency decreased. Increases in delta K increased the saturation CGR and shifted the data to lower frequencies. Increases in temperature shifted the CG response curve to higher frequencies, which correspond to an apparent activation energy of 30 kJ/mol. A modeling framework was developed to link the chemical and mechanical processes occurring at the crack-tip. A model for the CG response, as a function of f and T, was developed based on the kinetic response of the transient surface reactions. The CG response is related to the charge transferred during the transient reactions, which explains the frequency and temperature dependence in terms of reaction kinetics and time. A model for the CGR magnitude, as a function of K(sub max) and the saturation charge transfer level, was developed based on the distribution of hydrogen at the crack-tip. The model accounts for the effect of K on the

CGR in terms of its effect on the hydrogen distribution and the local crack-tip environment. (Dissert. Abstr.)
DESCRIPTORS: *AQUEOUS SOLUTIONS; *CORROSION; *CRACK PROPAGATION; *CRACK TIPS; *CYCLIC LOADS; *HIGH STRENGTH STEELS; *METAL FATIGUE; *REACTION KINETICS; *STRESS INTENSITY FACTORS; *SURFACE REACTIONS; ACTIVATION ENERGY; AUGMENTATION; CHARGE TRANSFER; FREQUENCIES; HYDROGEN; PURITY; REACTION TIME ; TEMPERATURE DEPENDENCE
SUBJECT CLASSIFICATION: 7526 Metallic Materials (1975-)

31.

15257056 Genuine Article#: VU937 Number of References: 30
Title: A MICROMECHANICS MODEL OF CORROSION-FATIGUE CRACK-GROWTH IN STEELS
Author(s): DELOSRIOS ER; WU XD; MILLER KJ
Corporate Source: UNIV SHEFFIELD,FAC ENGN,SIRIUS,MAPPIN ST/SHEFFIELD S1 3JD/S YORKSHIRE/ENGLAND/
Journal: FATIGUE & FRACTURE OF ENGINEERING MATERIALS & STRUCTURES, 1996, V 19, N11, P1383-1400
ISSN: 8756-758X
Language: ENGLISH Document Type: ARTICLE
Abstract: Principles of Microstructural Fracture Mechanics (MFM) are used to develop a model for the characterization of environment-assisted short fatigue crack growth. Fatigue cracks are invariably initiated at corrosion pits formed at inclusions, hence the analysis includes stress concentration effects at pits that lead to the propagation of fatigue cracks the rates of which are considered to be proportional to the crack tip plastic displacement. This plasticity is constrained by microstructural barriers which are overcome in a non-aggressive environment at critical crack lengths only when the applied stress is higher than the fatigue limit. However, the superposition of an aggressive environment assists fatigue damage via crack tip dissolution, enhancement of crack tip plastic deformation, the introduction of stress concentrations at pits and a reduction of the strength of the microstructural barrier. These environment effects are manifested in st drastic reduction of the fatigue limit and higher crack propagation rates.
The model is compared with fatigue crack propagation data of a BS251A58 steel tested in reversed torsion when submerged in a 0.6M NaCl solution.

32.

799515 199706-R5-0836
Environmental fatigue in a 7000 series aluminium alloy.
Ruiz, J ; Elices, M
CORPORATE SOURCE: Universidad Politecnica de Madrid
JOURNAL: Corrosion Science, 38, (10), 1815-1837 ISSN: 0010-938X
PUBL. DATE: Oct. 1996
USA, 1996
COUNTRY OF PUBLICATION: USA
JOURNAL ANNOUNCEMENT: 9706
DOCUMENT TYPE: Article
LANGUAGE: ENGLISH
ABSTRACT: The effect of water vapor pressure on fatigue crack growth in an aluminium alloy is analyzed in this investigation. Fatigue tests were performed in gaseous atmospheres with different water vapor concentrations

and the experimental results were correlated with the morphology of the fracture surfaces examined by SEM. An important effort has been made in thoroughly examining the characteristic features associated with the fatigue fracture for environments with different water vapor pressures. Crack growth response at the lower water vapor pressured (between 1-5 Pa) is satisfactorily explained in terms of a model based on the hypothesis of hydrogen embrittlement. Specific material: 7017. Photomicrographs; Spectra ; Graphs. 25 ref.

DESCRIPTORS: Journal Article; Aluminum base alloys-- Mechanical properties; Corrosion fatigue; Crack propagation; Fatigue tests; Water vapor-- Environment; Al Zn Mg alloys

ALLOY INDEX(IDENTIFIER): 7017-- AL

SECTION HEADINGS: R5 (Mechanical Properties); R6 (Corrosion/Electrochemistry/Chemical Reactions)

33.

797271 199703-R6-0095

Recent advances in the environment sensitive fracture mechanisms of aluminium alloys.

Magnin, Th

CORPORATE SOURCE: Ecole des Mines

CONFERENCE: Aluminium Alloys--Their Physical and Mechanical Properties. ICAA5. Part 1, Grenoble, France, 1-5 July 1996 JOURNAL: Materials Science Forum, 217-222, (1), 83-94 ISSN: 0255-5476

PUBL. DATE: 1996

1996

JOURNAL ANNOUNCEMENT: 9703

DOCUMENT TYPE: Conference Paper

LANGUAGE: ENGLISH

ABSTRACT: A nonexhaustive review of recent advances in the stress corrosion and corrosion fatigue cracking processes of Al alloys is presented, mainly for Al-Cu, Al-Mg and Al-Zn-Mg alloys. The interactions between corrosion fatigue and stress corrosion cracking emphasizes some differences between the two damages. The competition between anodic dissolution and hydrogen effects during stress corrosion cracking leads to introduce the notion of critical surface defect for H embrittlement. Recent mechanisms based on localized corrosion-deformation interactions are then described together with the micro-crystallographic features in single and polycrystals. Finally new numerical simulations of environment sensitive damage and cracking are presented. Photomicrographs; Graphs. 17 ref.

DESCRIPTORS: Conference Paper; Aluminum base alloys-- Corrosion; Corrosion fatigue; Stress corrosion cracking; Hydrogen embrittlement; Anodic dissolution; Sodium chloride-- Environment; Computer simulation; Surface defects; Fracture mechanics; Al Zn Mg Cu alloys; Al Cu alloys; Al Zn Mg alloys

ALLOY INDEX(IDENTIFIER): 7150-- AL/Al-4Cu-- AL/7020-- AL

SECTION HEADINGS: R6 (Corrosion/Electrochemistry/Chemical Reactions)

34.

797236 199703-R5-0425

Corrosion-fatigue life prediction for notched components based on the local strain and linear elastic fracture mechanics concepts.

Khan, Z ; Younas, M

CORPORATE SOURCE: King Fahad University of Petroleum and Minerals
JOURNAL: International Journal of Fatigue, 18, (7), 491-498 ISSN: 0142-1123
PUBL. DATE: Oct. 1996
UK, 1996
COUNTRY OF PUBLICATION: UK
JOURNAL ANNOUNCEMENT: 9703
DOCUMENT TYPE: Article
LANGUAGE: ENGLISH
ABSTRACT: An initiation-propagation model based on the local strain and linear elastic fracture mechanics concepts has been investigated for application to predict the fatigue life of notched components exposed to a corrosive environment. Estimates of the corrosion-fatigue crack initiation lives were obtained using strain-life relationships. The Paris power law was used to obtain the estimates of corrosion-fatigue crack propagation lives. Estimated corrosion-fatigue lives were compared with the experimentally obtained corrosion-fatigue life data using center-notched specimens of three types of modified Al-2.5Mg alloy exposed to an Arabian Gulf seawater environment. Good fatigue life estimates were obtained both in air and in Arabian Gulf seawater environments for all three types of alloy. It is shown that good corrosion-fatigue life predictions can be made by determining the relevant fatigue parameters via a few simple constant-amplitude fatigue tests on smooth specimens and a few crack growth rate tests in the environment at the frequency of interest. Graphs. 29 ref.
DESCRIPTORS: Journal Article; Aluminum base alloys-- Mechanical properties; Magnesium-- Alloying elements; Corrosion fatigue; Fracture mechanics; Sea water-- Environment
SECTION HEADINGS: R5 (Mechanical Properties)

35.

793764 199610-R6-0453
Influence of surface defects on hydrogen effects during stress corrosion and corrosion fatigue.
Magnin, T ; Najjar, D
CORPORATE SOURCE: a Ecole Nationale Superieure des Mines de Saint-Etienne
CONFERENCE: Hydrogen Transport and Cracking in Metals, Teddington, UK, 13-14 Apr. 1994 JOURNAL: Hydrogen Transport and Cracking in Metals., 38-49 ISSN: 0-901716-67-7
PUBL: Institute of Materials, 1 Carlton House Terrace, London, SW1Y 5DB, United Kingdom, 1995
COUNTRY OF PUBLICATION: United Kingdom
JOURNAL ANNOUNCEMENT: 9610
DOCUMENT TYPE: Conference Paper
LANGUAGE: ENGLISH
ABSTRACT: Stress corrosion cracking and corrosion fatigue damage in metals and alloys often involve a competition between anodic dissolution and H effects, in regard to localized plasticity. The respective roles of dissolution and H still remain controversial. The aim of the paper is to bring an original contribution to the question through the notion of critical defect for H effects during stress corrosion cracking and corrosion fatigue. It is shown that the presence of microcracks and/or other surface defects strongly favours the H entry and subsequent H embrittlement (decohesion, enhanced plasticity or hydride formation) in many different systems. This experimental observation is of great interest

to model the SCC and CF behaviour of many alloys at a microscopic scale. Examples of the effects of surface microcracks formed in fatigue on CF damage are first given for ferritic stainless steels and aluminium alloys in chloride solutions. Then a more detailed analysis of the influence of surface defects created by localized dissolution is presented for Al alloys and applied to austenitic stainless steels during SCC. Graphs; Photomicrographs. 15 ref.

DESCRIPTORS: Conference Paper; Aluminum base alloys-- Corrosion; Austenitic stainless steels-- Corrosion; Ferritic stainless steels-- Corrosion; Stress corrosion cracking; Corrosion fatigue; Hydrogen embrittlement; Al Zn Mg alloys; Al Zn Mg Cu alloys

ALLOY INDEX(IDENTIFIER): 7020-- AL/7150-- AL/Al-Mg-Zn-- AL

SECTION HEADINGS: R6 (Corrosion/Electrochemistry/Chemical Reactions)

36.

793650 199610-R5-1171

Modelling environment-assisted short fatigue crack growth.

Akid, R

CORPORATE SOURCE: a University of Sheffield

CONFERENCE: 8th International Conference on Fracture. ICF8, Kyiv, Ukraine, 8-14 June 1993 JOURNAL: Advances in Fracture Resistance and Structural Integrity, 261-269 ISSN: 0-08-042256-X

PUBL. DATE: 1994

PUBL: Elsevier Science Ltd., Oxford Fulfillment Centre, P.O. Box 800, Kidlington, Oxford OX5 1DX, UK, 1994

COUNTRY OF PUBLICATION: UK

JOURNAL ANNOUNCEMENT: 9610

DOCUMENT TYPE: Conference Paper

LANGUAGE: ENGLISH

ABSTRACT: The role of small defect growth in the lifetime of a component is of paramount importance for high strength structural materials in which initial surface defects are of negligible size and where sub-critical threshold crack growth dominates the fatigue lifetime. Conventional fracture mechanics does not permit a suitable analyses of fatigue crack growth since early environment-assisted fatigue crack growth (EAFCG) is dominated by a "chemical" effect rather than by mechanical stress. Several research studies have now been conducted on a variety of materials under different loading and electrochemical conditions. The results of these studies indicate that localised corrosion, either in the form of pitting or slip band dissolution, plays a major part in reducing/eliminating the fatigue limit or endurance limit of materials in aggressive environments. The paper presented here highlights the important mechanisms that contribute to the total corrosion fatigue lifetime. In addition models are presented that allow the prediction of environment-assisted crack growth rates under either shear or tensile loading conditions. Graphs. 10 ref.

DESCRIPTORS: Conference Paper; Low carbon steels-- Mechanical properties; Medium carbon steels-- Mechanical properties; Stainless steels-- Mechanical properties; Aluminum base alloys-- Mechanical properties; Lithium-- Alloying elements; Crack propagation-- Corrosion effects; Fatigue life-- Corrosion effects; Al Li alloys

ALLOY INDEX(IDENTIFIER): Al-Li-- AL

SECTION HEADINGS: R5 (Mechanical Properties)

37.

793046 199609-R6-0404

Pitting effects on the corrosion fatigue life of 7075-T6 aluminum alloy .

Ma, L

CORPORATE SOURCE: University of Utah

JOURNAL: Dissertation Abstracts International, 55, (4), Pp 168 ISSN: 0419-4217

PUBL. DATE: Oct. 1994

USA, 1994

COUNTRY OF PUBLICATION: USA

REPORT NO.: DA9423672

JOURNAL ANNOUNCEMENT: 9609

DOCUMENT TYPE: Dissertation

LANGUAGE: ENGLISH

ABSTRACT: A high-strength aluminum alloy, 7075-T6, was studied to quantitatively evaluate chemical pitting effects on its corrosion fatigue life. The study focused on pit nucleation, pit growth, and fatigue crack nucleation. Pitting corrosion fatigue experiments were conducted in 3.5% NaCl aqueous solution under constant amplitude sinusoidal loading at two frequencies, 5 and 20 Hz. The smooth and unnotched specimens were used in this investigation. A video recording system was developed to allow in situ observation of the surface changes of the specimens during testing. The results indicated that pitting corrosion considerably reduces the fatigue strength by accelerating fatigue crack nucleation. The average pit nucleation life which was the number of cycles to the first observed pit at the length of about 0.02 mm on the exposed surface was about 35% of the total corrosion fatigue life. No appreciable frequency effect was observed in the pit nucleation process for the frequencies evaluated. However, a frequency effect was found in the total corrosion fatigue life. The reduced fatigue life at the lower frequency (5 Hz) can be attributed to increased exposure time allowing more corrosion to occur promoting pit growth. The fractography of the tested specimens showed that corner corrosion pits were responsible for fatigue crack nucleation in the material due to the associated stress concentration. The pits exhibited variance of morphology. Fatigue life for the experimental conditions appeared to be strongly dependent on pitting kinetics and the crack nucleation stage. Examination by metallographically cross-sectioning the pits showed that the pits shape might vary with growth. The growth of the pit depended strongly on the orientation with respect to the rolling direction of the material. It was also found that intergranular corrosion damage along with pitting suggests that intergranular attack might lead to fatigue cracking. A three-dimensional finite element model was developed for calculating Mode I stress intensity factors at a quarter-elliptical corner pit by assuming the pit was a quarter-elliptical corner crack. Two different configuration parameters of the pit were modeled and the results were discussed. Based on the finite element results, the maximum stress intensity range based on a real pit size measured from the fracture surface of the tested specimen was considered as the threshold stress intensity range (Delta K sub th). This value was compared with experimental data of the corrosion fatigue crack growth with the same material and environment from the literature. Finally, a conceptual model of pitting corrosion fatigue proposed by Hoeppner was verified using the result of the finite element analysis and the experimental data. Further research to improve the accuracy of the prediction is suggested.

DESCRIPTORS: Dissertation; Aluminum base alloys-- Corrosion; Fatigue life -- Corrosion effects; Corrosion fatigue; Pitting (corrosion); Sodium

chloride-- Environment; Fractography; Al Zn Mg Cu alloys
ALLOY INDEX(IDENTIFIER): 7075-- AL
SECTION HEADINGS: R6 (Corrosion/Electrochemistry/Chemical Reactions)

38.

788874 199603-R6-0125
A mechanistically based probability approach for predicting corrosion and corrosion fatigue life.
Wei, R P ; Harlow, D G
CORPORATE SOURCE: Lehigh University
CONFERENCE: 17th Symposium of the International Committee on Aeronautical Fatigue, Stockholm, Sweden, 9-11 June 1993 JOURNAL: Durability and Structural Integrity of Airframes. Vol. I, 347-366 ISSN: 0-947817-68-9
PUBL. DATE: 1993
PUBL: Engineering Materials Advisory Services Ltd., 339 Halesowen Rd. Cradley Heath, Warley, West Midlands B64 6PH, United Kingdom, 1993
COUNTRY OF PUBLICATION: United Kingdom
JOURNAL ANNOUNCEMENT: 9603
DOCUMENT TYPE: Conference Paper
LANGUAGE: ENGLISH
ABSTRACT: A mechanistically based probability approach to life prediction is described. Differences between statistical and mechanistic modeling are addressed, and the need for this approach is demonstrated. The process is illustrated through simplified modeling of pitting and corrosion fatigue of aluminum alloys in aqueous environments, using assumed (but realistic) data and probability density functions (PDFs). The ability to provide predictions of life beyond the range of available data and assessments of the significance of each random variable is demonstrated. It is also shown that probability considerations must be integral to the entire process, and cannot be ex post facto appendages to mechanistic studies. Confidence levels for the predictions are not addressed and the numerical results presented are an indication of trends only. Graphs; Photomicrographs. 11 ref. DESCRIPTORS: Conference Paper; Aluminum base alloys-- Corrosion; Pitting (corrosion); Corrosion fatigue; Fatigue life; Mathematical models; Forecasting; Al Cu Mg Mn alloys
ALLOY INDEX(IDENTIFIER): 2024-- AL
SECTION HEADINGS: R6 (Corrosion/Electrochemistry/Chemical Reactions)

39.

784611 199509-R5-0900
Fundamentals of corrosion fatigue.
Magnin, T
CORPORATE SOURCE: CNRS
CONFERENCE: Fatigue 93. 5th International Conference on Fatigue and Fatigue Thresholds. Vol. II, Montreal, Quebec, Canada, 3-7 May 1993 733-744
PUBL. DATE: 1993
PUBL: Engineering Materials Advisory Services Ltd., 339 Halesowen Rd., Cradley Heath, Warley, West Midlands B64 6PH, United Kingdom, 1993
COUNTRY OF PUBLICATION: United Kingdom
JOURNAL ANNOUNCEMENT: 9509
DOCUMENT TYPE: Conference Paper; Review
LANGUAGE: ENGLISH

ABSTRACT: A nonexhaustive review of recent advances on corrosion fatigue mechanisms is presented. It focuses on the localized corrosion (dissolution, adsorption)-deformation interactions for smooth and precracked specimens. Micromechanisms of crack initiation and crack propagation near the CF threshold are discussed from microfractographic observations. Interactions between CF and SCC are described. Numerical simulations are then proposed to quantify CF damage from physico-chemical factors. Photomicrographs; Graphs. 25 ref.

DESCRIPTORS: Conference Paper; Review; Austenitic stainless steels-- Mechanical properties; Ferritic stainless steels-- Mechanical properties; Nickel chromium molybdenum steels-- Mechanical properties; Aluminum base alloys-- Mechanical properties; Corrosion fatigue; Crack initiation; Crack propagation; Al Li Cu Mg alloys; Al Zn Mg alloys

ALLOY INDEX(IDENTIFIER): 8090-- AL/7020-- AL

SECTION HEADINGS: R5 (Mechanical Properties)

40.

784093 199508-R6-0255

Environment sensitive fracture mechanisms.

Magnin, T

CORPORATE SOURCE: Universite de Lille

CONFERENCE: Dislocations 93, Aussois, France, 31 Mar.-9 Apr. 1993

JOURNAL: Solid State Phenomena, 35-36, 319-333

PUBL. DATE: 1994

1994

JOURNAL ANNOUNCEMENT: 9508

DOCUMENT TYPE: Article; Conference Paper; Review

LANGUAGE: ENGLISH

ABSTRACT: Fundamentals on stress corrosion cracking (SCC) and corrosion-fatigue (CF) are presented through recent studies of corrosion-deformation interactions (CDI). Theoretical approaches of SCC and CF damage are first proposed from polarization curves, in conditions of pitting, localized dissolution and hydrogen reduction. It is then clearly shown that the study of CDI is necessary to approach the experimental results, particularly to analyze how a fcc ductile alloy (316L) can exhibit a cleavage-like fracture in an aqueous solution. Different recent models based on localized dissolution and/or H-plasticity interactions (on 8090 Al-Li alloy in NaCl solutions) are reviewed together with the role of surface layers. Numerical simulations of the CDI at a stress corrosion crack tip and of surface microcracking in CF are finally presented to quantify the environment sensitive fracture mechanisms. Graphs; Photomicrographs. 28 ref.

DESCRIPTORS: Journal Article; Conference Paper; Review; Austenitic stainless steels-- Corrosion; Aluminum base alloys-- Corrosion; Lithium-- Alloying elements; Stress corrosion cracking; Corrosion fatigue; Fracture mechanics-- Corrosion effects; Al Li Cu Mg alloys

ALLOY INDEX(IDENTIFIER): 8090-- AL/8090-- AL

SECTION HEADINGS: R6 (Corrosion/Electrochemistry/Chemical Reactions)

41.

782274 199506-B5-0212

Failures of structures and components by environmentally assisted cracking.

Lynch, S P
CORPORATE SOURCE: Department of Defence (Australia)
JOURNAL: Eng. Fail. Anal., 1, (2), 77-90 ISSN: 1350-6307
PUBL. DATE: June 1994
1994
JOURNAL ANNOUNCEMENT: 9506
DOCUMENT TYPE: Article
LANGUAGE: ENGLISH
ABSTRACT: General procedures for analysing failures, especially where environmentally assisted cracking is suspected, are outlined. Specific examples of failures caused by, for example, stress cracking, corrosion fatigue, hydrogen embrittlement and liquid-metal embrittlement in aluminium alloys, high-strength steels, and other materials are described, and possible ways of preventing such failures are suggested. Failures of high-strength steel components, and ways of differentiating between the many failure models which can produce brittle intergranular fractures along prior-austenite grain boundaries, are discussed in particular. Graphs; Photomicrographs; Diffraction Patterns. 15 ref.
DESCRIPTORS: Journal Article; Aluminum base alloys-- End uses; Copper base alloys-- End uses; High strength low alloy steels-- End uses; Austenitic stainless steels-- End uses; Aircraft components-- Corrosion; Stress corrosion cracking; Intergranular fracture; Liquid metal embrittlement; Al Zn Mg Cu alloys
ALLOY INDEX(IDENTIFIER): 7075-- AL/7050-- AL
SECTION HEADINGS: B5 (Products/Applications/Competitive Materials)

42.

778879 199412-R6-0447
Corrosion-Deformation Interactions During Environment Sensitive Damage.
Magnin, T
CORPORATE SOURCE: Ecole Nationale Superieure des Mines de Saint-Etienne
CONFERENCE: Strength of Materials. ICSMA 10, Sendai, Japan, 22-26 Aug. 1994 25-32
PUBL: Japan Institute of Metals, Nihon Kinzoku Gakkai Aoba,Aramaki, Sendai, 980, Japan, 1994
COUNTRY OF PUBLICATION: Japan
JOURNAL ANNOUNCEMENT: 9412
DOCUMENT TYPE: Conference Paper
LANGUAGE: ENGLISH
ABSTRACT: The environment sensitive damage and fracture processes in metals and alloys can often be analysed in terms of corrosion-deformation interactions. Examples of such interactions are presented, both for the effects of the electrochemical reactions on the dislocation behaviour and for the influence of plasticity on the corrosion processes. Based on these interactions, some models for cleavage-like fracture in ductile fcc alloys during stress corrosion cracking are reviewed. The corrosion (dissolution and/or absorption) enhanced plasticity model is presented in more detail. The relevance of corrosion-deformation interactions to analyse the stress corrosion and corrosion fatigue mechanisms is then discussed. (Examples include aluminum 8090, 316SS and Inconel 690.) Photomicrographs; Graphs. 17 ref.
DESCRIPTORS: Conference Paper; Aluminum base alloys-- Corrosion; Austenitic stainless steels-- Corrosion; Nickel base alloys-- Corrosion; Stress corrosion cracking; Chlorides-- Environment; Fracture mechanics;

Anodic dissolution; Corrosion fatigue; Superalloys; Al Li Cu Mg alloys
ALLOY INDEX(IDENTIFIER): 8090-- AL
SECTION HEADINGS: R6 (Corrosion/Electrochemistry/Chemical Reactions)

43.

776338 199408-R6-0290
Crevice Corrosion: Review of Mechanisms, Modelling, and Mitigation.
JOURNAL: Br. Corros. J., 28, (4), 279-295 ISSN: 0007-0599
PUBL. DATE: 1993 .
UK, 1993
COUNTRY OF PUBLICATION: UK
JOURNAL ANNOUNCEMENT: 9408
DOCUMENT TYPE: Article; Review
LANGUAGE: ENGLISH
ABSTRACT: The proposed mechanisms for crevice corrosion in sea water and in other environments where alternative cathodic reduction processes may occur, are reviewed. The use of mathematical modelling is described together with laboratory methods of investigating crevice corrosion initiation and propagation. Such experimental methods may enable ranking of materials by assessing their resistance to crevice corrosion in a range of environments. However, a number of important factors such as crevice geometry, solution composition, temperature, and alloy composition may also have a bearing on crevice corrosion behaviour for a range of passive metals and alloys including steel, stainless steel, titanium, aluminium, and copper. Examples of failures in some of these alloys are discussed and how these could have been prevented by using good design and fabrication practices, sealants, and surface coatings. Materials selection and electrochemical technology such as cathodic protection are also important control measures that are frequently overlooked. The importance of sound, good quality welding practices to prevent the onset of crevice corrosion in defects caused by lack of weld metal fusion, overlap, and surface slag is also emphasised. It is frequently necessary to employ several or all of these techniques to combat crevice corrosion, since this form of localised attack, which shares many similarities with other forms such as pitting, corrosion fatigue, and stress corrosion cracking, is not always recognised as being more destructive. Graphs. 104 ref.
DESCRIPTORS: Journal Article; Review; Stainless steels-- Corrosion; Carbon steels-- Corrosion; Titanium-- Corrosion; Aluminum-- Corrosion; Crevice corrosion; Corrosion mechanisms; Corrosion prevention; Mathematical models
SECTION HEADINGS: R6 (Corrosion/Electrochemistry/Chemical Reactions)

44.

771830 199401-R5-0127
Orientation Effects on the Corrosion Fatigue Behaviour of Aluminium Alloy 7150.
Gingell, A D B ; King, J E
CORPORATE SOURCE: University of Cambridge
CONFERENCE: Corrosion--Deformation Interactions, Fontainebleau, France, 5-7 Oct. 1992 295-307
PUBL: Les Editions de Physique, Avenue du Hoggar, Zone Industrielle de Courtaboeuf, B.P. 112, F-91944 Les Ulis Cedex A, France, 1993
COUNTRY OF PUBLICATION: France

JOURNAL ANNOUNCEMENT: 9401
DOCUMENT TYPE: Conference Paper
LANGUAGE: ENGLISH
ABSTRACT: The fatigue crack propagation behaviour of a high strength aluminium alloy has been studied in both air and acidified salt solution. Fatigue crack propagation curves in air have been obtained for the six possible mode I orientations present in plate material, and fractographic analysis has been used to characterise the fatigue crack growth modes. In acidified salt solution, there is a significant enhancement in fatigue crack growth rate which is greater at lower cyclic frequencies. The acceleration in fatigue crack growth rates occurs predominantly at intermediate to high stress intensity ranges and is associated with transgranular and brittle striated crack growth. In the L-S orientation, fatigue in air and salt solution occurred in a transgranular manner with significant grain boundary splitting normal to the crack plane, leading to crack path deviation. The effect of frequency on environmental enhancement of crack growth rates suggests diffusion control rather than a superposition model for corrosion fatigue. Graphs; Photomicrographs. 9 ref. DESCRIPTORS: Conference Paper; Aluminum base alloys-- Mechanical properties; Fatigue (materials)-- Orientation effects; Crack propagation-- Orientation effects; Transgranular fracture-- Orientation effects; Brittle fracture-- Orientation effects; Orientation; Diffusion; Corrosion fatigue; Stress intensity; Al Zn Mg Cu alloys
ALLOY INDEX(IDENTIFIER): 7150, Al-6.22Zn-2.33Mg-2.24Cu-- AL
SECTION HEADINGS: R5 (Mechanical Properties)

45.

752828 91-640279
Accelerated Corrosion Fatigue Test Methods for Aging Aircraft.
Smith, S H ; Christman, T K ; Brust, F W ; Oliver, M L
CORPORATE SOURCE: Battelle, Society for Experimental Mechanics
CONFERENCE: 1991 SEM Spring Conference on Experimental Mechanics, Milwaukee, Wisconsin, USA, 10-13 June 1991 328-335
PUBL: The Society for Experimental Mechanics, Inc., 7 School St., Bethel, Connecticut 06801, USA, 1991
JOURNAL ANNOUNCEMENT: 9111
DOCUMENT TYPE: CONFERENCE PAPER
LANGUAGE: ENGLISH
ABSTRACT: The results of recently developed analytical and experimental methods for corrosion fatigue evaluation of aging aircraft structures are presented. The accelerated corrosion simulation techniques which were used are those experimental techniques for corrosion pitting and exfoliation corrosion as recommended by American Society of Testing and Materials (ASTM). The corrosion mechanism produced multisite fatigue damage initiation and subsequent fatigue cracking in specimens consisting of a collinear array of open fastener holes and subjected to a uniform tension cyclic stress. Various methods utilized in deriving linear elastic stress intensity factor solutions for multisite cracks emanating at a collinear array of fastener holes were examined for application to the experimental fatigue results. The experimental techniques, special instrumentation, and constant amplitude fatigue results for baseline and corroded 7075-T6, T651, and 2024-T3, T351 bare Al alloys are presented. Graphs, Photomicrographs. 9 ref.--AA(US).
DESCRIPTORS: US wrought alloy 2024-- Testing; Al Cu Mg Mn wrought alloys

-- Testing; US wrought alloy 7075-- Testing; Al Zn Mg Cu wrought alloys-- Testing; Aircraft-- Testing; Accelerated tests; Salt spray tests; Corrosion fatigue; Pitting (corrosion); Exfoliation corrosion
SECTION HEADINGS: 64 (Corrosion)

46.

746976 91-640027
Mechanisms of Intrinsic Damage Localization During Corrosion Fatigue: Al--Li--Cu System.
Piacik, R S
CORPORATE SOURCE: University of Virginia
JOURNAL: Dissertation Abstracts International, 51, (3), Pp 387 ISSN: 0419-4217
PUBL. DATE: Sept. 1990
JOURNAL ANNOUNCEMENT: 9101
DOCUMENT TYPE: ARTICLE
LANGUAGE: ENGLISH
ABSTRACT: Mechanisms of crack tip damage fundamental to environmentally assisted fatigue crack growth in Al--Li--Cu alloys are studied. Intrinsic mechanisms of fatigue crack growth in peak aged alloy 2090 are examined by fracture mechanics methods applied to small, through-thickness, edge cracks sized between 0.3-5 mm. Two regimes of environmental effect, low mean stress-high stress intensity and high R threshold cracking are studied by programmed constant stress intensity experimentation. The electrical potential difference monitored crack growth studies are performed in ultra-high purified helium oxygen, water vapor, vacuum and aqueous sodium chloride environments. Results show that fatigue crack growth rates increase by up to 50 fold according to the environmental order: equal in vacuum, helium, oxygen; moist air; NaCl with cathodic polarization; water vapor; NaCl with anodic polarization. For water vapor and aqueous NaCl, alloy 2090 exhibits superior corrosion fatigue crack growth kinetics compared to 7000 series alloys and equivalent to 2000 series alloys. The effects of water vapor are pronounced near threshold with crack rates accelerated at extremely low water vapor pressures. Near threshold, high R results are consistent with fast surface reaction and gas phase transport limited kinetics modeling. Cracking in chloride solutions is accelerated by anodic polarization and retarded by cathodic polarization. A mild increase in aqueous crack growth rates is observed with increased loading frequency. Longitudinal-transverse (L-T) and longitudinal-short (L-S) corrosion fatigue is transgranular (slip band, subboundary and cleavage cracking) with little influence of high angle grain boundaries. Intrinsic corrosion fatigue crack growth kinetics are interpreted based on the dominant role of hydrogen embrittlement in the crack tip cyclic plastic zone. (DA9024671).--AA.
DESCRIPTORS: US wrought alloy 2090-- Stress corrosion; Al Cu Li Zr wrought alloys-- Stress corrosion; Corrosion fatigue-- Microstructural effects; Fatigue failure-- Microstructural effects; Crack propagation; Intergranular fractures
SECTION HEADINGS: 64 (Corrosion)

47.

740214 90-640120
Chemical and Microstructural Aspects of Corrosion Fatigue Crack Growth.

Wei, R P
CORPORATE SOURCE: Lehigh University, ASM International
CONFERENCE: Fracture Mechanics: Microstructure and Micromechanisms, Cincinnati, Ohio, USA, 10-11 Oct. 1987 229-254
PUBL: ASM International, Metals Park, Ohio 44073, USA, 1989
JOURNAL ANNOUNCEMENT: 9004
DOCUMENT TYPE: CONFERENCE PAPER
LANGUAGE: ENGLISH
ABSTRACT: Corrosion fatigue crack growth in high-strength alloys is known to be influenced by a range of chemical and microstructural variables in concert with the important mechanical variables. Modeling of corrosion fatigue crack growth response in terms of the underlying chemical processes and of microstructure has been made and now provides a framework for quantitative understanding and prediction of crack growth response in terms of these variables. The development of models for corrosion fatigue crack growth in gaseous and aqueous environments is reviewed. The influences of different variables (such as frequency, temperature, pressure, electrode potential, and microstructure) on corrosion fatigue crack growth response are considered in relation to these models and are illustrated by data on high-strength alloys. Alloys studied include Al alloy 7075, Ti alloy Ti--6Al--4V and steels 4340 and 2.25Cr--1Mo. , . 45 ref.--AA(UK/US).
DESCRIPTORS: US wrought alloy 7075-- Stress corrosion; Corrosion fatigue; Stress corrosion cracking; Mathematical models; Corrosion environments
SECTION HEADINGS: 64 (Corrosion)

48.

738785 90-640042
Environmentally Assisted Fatigue Crack Growth.
Wei, R P
CORPORATE SOURCE: Lehigh University
CONFERENCE: Advances in Fatigue Science and Technology, Alvor, Portugal, 4-15 Apr. 1988 221-252
PUBL: Kluwer Academic Publishers, P.O. Box 17, 3300 AA Dordrecht, The Netherlands, 1989
JOURNAL ANNOUNCEMENT: 9002
DOCUMENT TYPE: CONFERENCE PAPER
LANGUAGE: ENGLISH
ABSTRACT: Modelling of environmentally assisted fatigue (or corrosion fatigue) crack growth, in terms of environmental variables and of microstructure, is presented. The models serve as a framework for understanding the mechanisms for corrosion fatigue and the crack growth response. Crack growth response is determined by the underlying rate controlling processes (transport, surface reaction and hydrogen diffusion), and can be modified by metallurgical processes such as strain induced hydride formation. The principal features of fatigue crack growth response and the current state of understanding are illustrated by data on structurally important alloys. The interactions between environment and microstructure are illustrated by recent results on a high-strength steel and an Al alloy. The need for utilizing such a framework and for environmental control in the study of fatigue mechanisms is emphasized. Implications for design are discussed. 50 ref.--AA(UK).
DESCRIPTORS: Corrosion fatigue-- Environmental effects; Hydrogen embrittlement-- Environmental effects; Crack propagation-- Environmental effects; Fatigue failure-- Environmental effects; Corrosion environments

SECTION HEADINGS: 64 (Corrosion)

49.

727199 88-610491

Mechanisms of Fatigue Crack Initiation in Metals: Role of Aqueous Environments.

Srivatsan, T S ; Sudarshan, T S

CORPORATE SOURCE: Materials Modification

JOURNAL: J. Mater. Sci., 23, (5), 1521-1533 ISSN: 0022-2461

PUBL. DATE: May 1988

JOURNAL ANNOUNCEMENT: 8809

DOCUMENT TYPE: ARTICLE

LANGUAGE: ENGLISH

ABSTRACT: Fatigue crack initiation in engineering materials has been the subject of considerable research. Most of these investigations focused on gaseous environment effects, and extensive review articles have appeared in recent times, discussing the role of gaseous environments on crack initiation. Because of experimental difficulties, the effect of aqueous environments on mechanisms of fatigue crack initiation has received little attention, despite their unquestionable importance from an engineering standpoint. In this review, several of the fatigue crack initiation models are examined in detail and their anomalies discussed for carbon steels (1035) and Al alloys (7075). The physics and micromechanisms of crack initiation during cyclic deformation in aqueous environments, which are highly corrosive in nature, are examined. The characteristics of the crack initiation process in aqueous environments are critically reviewed in the light of the specific role of several concurrent factors involving the nature of the aqueous medium, corrosion interactions, alloy chemistry, processing treatments, intrinsic microstructural effects and test variables. 105 ref.--AA(UK/US).

DESCRIPTORS: Airframes-- Fatigue (materials); Fatigue failure-- Environmental effects; Crack propagation-- Environmental effects; Corrosion fatigue-- Environmental effects

SECTION HEADINGS: 61 (Mechanical Properties)

50.

724629 88-640108

Kinetics of Corrosion Fatigue Crack Propagation Behavior of Al--Zn--Mg Alloy Using Center Notched Specimens.

Jang, J -Y ; Kim, H -P ; Pyun, S -I ; Choi, I -S

CORPORATE SOURCE: Central Research Institute of Gold Stars (Korea), Korea Advanced Institute of Science and Technology

JOURNAL: Br. Corros. J., 22, (4), 238-242 ISSN: 0007-0599

PUBL. DATE: 1987

JOURNAL ANNOUNCEMENT: 8805

DOCUMENT TYPE: ARTICLE

LANGUAGE: ENGLISH

ABSTRACT: The kinetics of corrosion fatigue (CF) crack propagation in an Al--Zn--Mg alloy were studied as a function of applied potential and temperature in a 3.5 wt.% NaCl solution using center notched specimens. This study especially concerned the stress corrosion (SC) crack propagation associated with CF crack propagation. CF crack propagation rate increased with increasing applied potential. CF and SC cracks both propagated in a

brittle, intergranular manner. CF crack propagation is thought to be an enhanced phenomenon of SC crack propagation. By modifying the simple superposition model, synergistic interaction between pure fatigue and environmental effects was taken into consideration in evaluating the CF crack propagation rate in terms of the SC crack propagation rate. The present experimental data also led to the conclusion that the CF crack propagation rate is simply proportional to (Delta K) exp 2.0--2.2 and Boltzmann's factor, where Delta K is the stress intensity range. The apparent activation energy for CF crack propagation was found to be approx 52 kJ mol exp --1 at the corrosion potential. The association of CF crack propagation with SC crack propagation supports the conclusion that CF crack growth is controlled by hydrogen embrittlement. 22 ref.--AA(Alfed/UK/US).

DESCRIPTORS: Al Zn Mg wrought alloys-- Stress corrosion; Corrosion fatigue-- Mechanisms; Crack propagation-- Mechanisms

SECTION HEADINGS: 64 (Corrosion)

51.

720187 87-640269

Electrochemical Aspects of the Corrosion Fatigue of an Aluminum Alloy of the Al--Zn--Mg System. (Translation).

Petrov, L N ; Olik, A P ; Borisov, V A ; Kalinkov, A Yu

JOURNAL: Sov. Mater. Sci., 22, (5), 468-472 ISSN: 0038-5565

PUBL. DATE: Sept.-Oct. 1986

JOURNAL ANNOUNCEMENT: 8710

DOCUMENT TYPE: ARTICLE

LANGUAGE: ENGLISH

ABSTRACT: Previously abstracted from original as item 8705-64-0123Y. The corrosion rate of an Al--Zn--Mg alloy (used in ship building) with a Zn/Mg weight ratio of 0.5 was measured in a 3% NaCl solution using a model galvanic couple that simulated conditions at the tip of a corrosion fatigue crack. The hydrogenated portion of the couple was produced by cathodic polarization in a 1N H2SO4 solution at 100 A/m exp 2 . Hydrogenation of the anode played an important role in the corrosion mechanics of fracture of this alloy. The rate of corrosion jumped from 0.005 to 4.45 mm/year upon hydrogenation. The application of a 400 MPa tensile stress raised the corrosion rate of the hydrogenated anode to 10.0 mm/year without affecting the unhydrogenated anode. Measurements of galvanic couples in freshly prepared and old surfaces of the alloy indicated a high initial current density of > 900 A/m exp 2 that dropped rapidly with time. 5 ref.--X-ref.(US).

DESCRIPTORS: Al Zn Mg wrought alloys-- Corrosion fatigue; Corrosion rate -- Diffusion effects; Corrosion potential-- Diffusion effects; Hydrogen-- Diffusion

SECTION HEADINGS: 64 (Corrosion)

52.

715866 87-640094

The Life Prediction for 2024-T3 Aluminum Alloy Subjected to Corrosion Fatigue.

So, H ; Kuo, W H

JOURNAL: J. Chin. Inst. Chem. Eng., 9, (5), 475-484

PUBL. DATE: 1986

JOURNAL ANNOUNCEMENT: 8704

DOCUMENT TYPE: ARTICLE
LANGUAGE: ENGLISH
ABSTRACT: Fatigue life prediction for 2024-T3 Al alloy sheet subjected to cyclic bending in a corrosive environment was done by using a Monte Carlo simulation in which three processes occurred. First, the crack distribution and crack size distribution functions were obtained experimentally. Second, the stress distribution, interaction of cracks, and crack propagation rate were found by using dislocation functions. Third, a coalescence interior is proposed to predict the formation of cross surface cracks. The predicted results were in agreement with experimental data.--Chem. Abs.
DESCRIPTORS: US wrought alloy 2024-- Corrosion fatigue; Al Cu Mg Mn wrought alloys-- Corrosion fatigue; Sheet metal-- Corrosion fatigue; Fatigue life-- Forecasting; Crack propagation-- Computer simulation
SECTION HEADINGS: 64 (Corrosion)

53.

714590 87-640029
The Influence of Environment on the Fatigue Properties of Aluminum Alloys.
Ricker, R E
CORPORATE SOURCE: The Metallurgical Society/AIME
CONFERENCE: Modeling Environmental Effects on Crack Growth Processes, Toronto, Canada, 13-17 Oct. 1985 371-380
PUBL: The Metallurgical Society/AIME, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, 1986
JOURNAL ANNOUNCEMENT: 8702
DOCUMENT TYPE: CONFERENCE PAPER
LANGUAGE: ENGLISH
ABSTRACT: Corrosion fatigue crack propagation models usually assume that the contribution of the pure mechanical fatigue process to failure in the aggressive environment is the same as measured in an inert reference environment. To evaluate the validity of this assumption, strain control bending fatigue tests were conducted on samples of an Al--Zn--Mg alloy and an Al--Mg--Li alloy in different environments. The results indicate that the cyclic fatigue strength coefficient and exponent of these alloys are altered by the test environment and that the assumption that the mechanical deformation and fatigue properties of alloys are not influenced by the test environment is not always valid. 36 ref.--AA(US).
DESCRIPTORS: Al Zn Mg wrought alloys-- Corrosion fatigue; Al Mg Li wrought alloys-- Corrosion fatigue; Fatigue failure-- Mathematical models; Fatigue life-- Environmental effects; Crack propagation-- Environmental effects
SECTION HEADINGS: 64 (Corrosion)

54.

702468 85-640120
Environmentally Assisted Fatigue-Crack Growth in 7075 and 7050 Aluminum Alloys.
Pao, P S ; Gao, M ; Wei, R P
CORPORATE SOURCE: McDonnell Douglas Research Laboratories
JOURNAL: Scr. Metall., 19, (3), 265-270 ISSN: 0036-9748
PUBL. DATE: Mar. 1985
JOURNAL ANNOUNCEMENT: 8506

DOCUMENT TYPE: ARTICLE
LANGUAGE: ENGLISH
ABSTRACT: Results of a study of the influences of yield strength and microstructure on environmentally assisted fatigue-crack growth in high-strength Al alloys are presented; the influences are analyzed on the basis of a model for transport-controlled fatigue-crack growth which incorporates many of the metallurgical, mehcanical, and environmental variables, based on the assumption that when the crack driving force is below that of the stress-corrosion cracking threshold the rate of fatigue-crack growth in a deleterious environment is the sum of the rate of fatigue-crack growth in an inert environment and a corrosion-fatigue component. 10 ref.--C.M.L.S.(UK/US).
DESCRIPTORS: US wrought alloy 7050-- Fatigue (materials); US wrought alloy 7075-- Fatigue (materials); Al Zn Mg Cu wrought alloys-- Fatigue (materials); Corrosion fatigue; Stress corrosion cracking; Crack propagation-- Environmental effects; Fatigue failure-- Corrosion effects
SECTION HEADINGS: 64 (Corrosion)

55.

197378 83-640257
Factors Controlling Crack Velocity in 7000 Series Aluminum Alloys During Fatigue in an Aggressive Environment.
Holroyd, N J H ; Hardie, D
CORPORATE SOURCE: Alcan International Ltd
JOURNAL: Corros. Sci., 23, (6), 527-546 ISSN: 0010-938X
PUBL. DATE: 1983
JOURNAL ANNOUNCEMENT: 8310
DOCUMENT TYPE: ARTICLE
LANGUAGE: ENGLISH
ABSTRACT: Results obtained for the corrosion fatigue of the Al--Zn--Mg alloy 7017-T651 in sea water at frequencies from 0.1 to 70 Hz are examined on the basis of existing models for predicting crack growth rates. The enhanced growth rates in sea water, compared with dry air, are not compatible with the simple superposition model that may be applied to 7079-T651, unless some secondary process produces several orders of magnitude increase over the stress corrosion rates observed under static loading. The changes in fracture mode observed at certain critical crack velocities and their dependence upon the square root of the reciprocal of the frequency of loading are shown to be consistent with an environment-enhanced crack growth rate involving diffusion of hydrogen ahead of the crack tip during each fatigue cycle. Examination of the reported frequency dependence of crack growth rates during corrosion fatigue in steels and other Al alloys indicates a need for further work to identify the rate-determining steps for crack propagation during corrosion fatigue. Theories proposed to date are found to be inadequate. 61 ref.--AA*.
DESCRIPTORS: Al Zn Mg wrought alloys-- Corrosion fatigue; US wrought alloy 7017-- Corrosion fatigue; US wrought alloy 7079-- Corrosion fatigue; Sea water-- Corrosion environments; Corrosion fatigue; Crack propagation-- Vibrational effects
SECTION HEADINGS: 64 (Corrosion)

56.

192959 83-640028
Corrosion Fatigue.
Congleton, J ; Craig, I H
JOURNAL: Corrosion Processes, 209-269
PUBL: Applied Science Publishers, London and New York, 1982
JOURNAL ANNOUNCEMENT: 8302
DOCUMENT TYPE: ARTICLE
LANGUAGE: ENGLISH
ABSTRACT: Crack initiation, the application of fracture mechanics to studies, crack growth, models and mechanisms and prevention are discussed. Fatigue crack growth equation Paris constant and Paris exponent values for 5086-H116, 5086-H117, 5456-H116, 5456-H117, 2219-T851 are tabulated. 125 ref.--EAA/AF.
DESCRIPTORS: US wrought alloy 5086-- Corrosion fatigue; US wrought alloy 5456-- Corrosion fatigue; US wrought alloy 2219-- Corrosion fatigue; Al Mg Mn wrought alloys-- Corrosion fatigue; Al Cu Mn wrought alloys-- Corrosion fatigue; Corrosion fatigue-- Mechanisms; Corrosion prevention
SECTION HEADINGS: 64 (Corrosion)

57.

190020 82-710141
An AGARD-Coordinated Corrosion Fatigue Cooperative Testing Program.
Wanhill, R J H ; De Luccia, J J
Pp 78
PUBL: Advisory Group for Aerospace Research and Development, 92200 Neuilly-sur-Seine, France, Feb. 1982
REPORT NO.: AGARD Rep. 695
JOURNAL ANNOUNCEMENT: 8209
DOCUMENT TYPE: REPORT
LANGUAGE: ENGLISH
ABSTRACT: The CFCTP, completed in mid-1981, was a program of round-robin testing by eight laboratories from Europe and North America. Air and salt spray environments were used. This report contains a manual specifying the technical requirements and test details and the core test results. The core program was for 3.2 mm 7075-T76 bare alloy sheet from one heat, using a dogbone specimen mechanically fastened by Cd-plated steel Hi-Loks from a single batch of fasteners. Protective systems and specimen treatments are specified. Supplemental pilot tests to determine the stress levels giving a desired uncorroded fatigue life covered 7075-T6 and 2024-T3. Core program environmental effects were significant and consistent. Examination with respect to fatigue origins and fracture surfaces is essential. The cleaning procedure after pre-exposure should be modified in further tests. A more extensive program, Aircraft Environmental Simulation Fatigue Testing (AESFT) is scheduled to be completed in 1984. (See also WAA 8202-6.4-0022Z; 8203-7.1-0028Z).--EAA/AF.
DESCRIPTORS: US wrought alloy 2024-- Corrosion fatigue; US wrought alloy 7075-- Corrosion fatigue; Al Cu Mg Mn wrought alloys-- Corrosion fatigue; Al Zn Mg Cu wrought alloys-- Corrosion fatigue; Corrosion fatigue-- Tests; Salt spray tests; Fatigue life
SECTION HEADINGS: 71 (Testing and Control)

58.

186644 82-640071

Mechanisms of Corrosion Fatigue of Aluminum Alloys.
Duquette, D J
CONFERENCE: Corrosion Fatigue, Cesme, Turkey, 5-10 Apr. 1981 1.1-1.12
PUBL: Advisory Group for Aerospace Research and Development, 92200 Neuilly sur Seine, France, Oct. 1981
REPORT NO.: AGARD Conf. No. 316
JOURNAL ANNOUNCEMENT: 8203
DOCUMENT TYPE: CONFERENCE PAPER
LANGUAGE: ENGLISH
ABSTRACT: An overview of experimental variables considered critical to understanding is presented and a model dependent on surface film integrity is proposed. Chemical or mechanical damage to the film allows exposure of hydrogen to emerging dislocations (slip planes) which effectively "pump" precipitate matrix interfaces and, through some still unknown specific mechanism, causes separation of the interfaces. The model is an extension of those previously proposed for SCC, except that the cyclic nature of the dislocation motion creates a preferentially high diffusion path into the process zone rather than into the normal high diffusivity zone of grain boundaries. A recent experimental program studying 7075 and its high-purity Al--Zn--Mg--Cu analog is summarized. 40 ref.--EAA/AF.
DESCRIPTORS: Corrosion fatigue-- Mechanisms; Corrosion fatigue-- Mathematical models; US wrought alloy 7075-- Corrosion fatigue; Al Zn Mg Cu wrought alloys-- Corrosion fatigue
SECTION HEADINGS: 64 (Corrosion)

59.

186180 82-640053
The Significance of Stress Corrosion Cracking in Corrosion Fatigue Crack Growth Studies.
Rhodes, D ; Musuva, J M ; Raydon, J C
JOURNAL: Eng. Fract. Mech., 15, (3-4), 407-419
PUBL. DATE: 1981
JOURNAL ANNOUNCEMENT: 8202
DOCUMENT TYPE: ARTICLE
LANGUAGE: ENGLISH
ABSTRACT: A model is proposed to account for interactions between fatigue and SCC-propagation mechanisms in appropriate corrosion fatigue conditions. Detailed test data plotted cover GB24ST-WP, RR58, LM30 and a steel. The new process interaction model appears to give better correlation than either superposition or competition models. 21 ref.--EAA/AF.
DESCRIPTORS: G Br casting alloy LM30-- Corrosion fatigue; G Br wrought alloy H16-- Corrosion fatigue; US wrought alloy 2024-- Corrosion fatigue; Al Si Cu Mg casting alloys-- Corrosion fatigue; Al Cu Mg wrought alloys-- Corrosion fatigue; Corrosion fatigue-- Mathematical models; Stress corrosion cracking
SECTION HEADINGS: 64 (Corrosion)

60.

1912316 MA Number: 199609-31-3259
Experiences in component testing for fatigue design.
Solin, J ; Marquis, G ; Santti, K
VTT
Conference: Fatigue Design 1995. Vol. III, Helsinki, Finland, 5-8 Sept.

1995
Publ: Technical Research Centre of Finland, Vuorimiehentie 5, P.O. Box 2000, Espoo, 02044, Finland, 1995
261-274 1995 ISSN: 951-38-4548-6
Country of Publication: Finland
Journal Announcement: 9609
Document Type: Conference Paper
Language: ENGLISH
Abstract: Accelerated service loading simulation is discussed in the context of component testing cases for the offshore and ground vehicle industries. Corrosion fatigue testing of a model cast X-node using an offshore spectrum at a low test frequency was accelerated through an intelligent omission procedure. The service simulation for a locomotive bogie frame required coordinated control of eight hydraulic actuators using five different spectrums. Realism for a reasonable cost and within an acceptable time frame is sought in the represented testing cases. Graphs. 15 ref.
Descriptors: Conference Paper; Offshore structures; Locomotives; Undercarriage-- Mechanical properties; Castings-- Mechanical properties; Steels-- Mechanical properties; Fatigue tests; High cycle fatigue; Fatigue life
Section Headings: 31 (MECHANICAL PROPERTIES)

61.

1873707 MA Number: 199510-22-1073
Accelerated Testing: Statistical Models, Test Plans, and Data Analyses.
Nelson, W
Publ: Wiley-Interscience, 605 Third Ave., New York, New York 10158-0012, USA, 1990
Accelerated Testing: Statistical Model, Test Plans, and Data Analyses Pp 601
Country of Publication: USA
Journal Announcement: 9510
Document Type: Book
Language: ENGLISH
Abstract: Use of statistical models, test plans, and data analyses to measure and improve product reliability is described. Applications and literature on accelerated testing of materials and products address electronics, insulations, semiconductors, plastics, and metals. Failure mechanisms considered include fatigue, creep, and corrosion. Discussed use of acceleration factors and life-stress relationships ranges from Arrhenius' to Zhurkov's. Construction and interpretation of data plots and estimation of product life from complete data are addressed. Cost effective test plans that yield accurate estimates of product reliability and analysis of life data containing a mix of failure modes and specimen sizes are described. Aging degradation of product performance is considered. Graphs. 421 ref.
Descriptors: Book; Statistical analysis; Data; Accelerated tests; Reliability
Section Headings: 22 (TESTING AND CONTROL)

62.

1793761 MA Number: 199308-35-1324

Test Methods for Environment Assisted Cracking.
Turnbull, A
National Physical Laboratory (UK)
British Corrosion Journal 27, (4), 271-289 1992 ISSN: 0007-0599
Country of Publication: UK
Journal Announcement: 9308
Document Type: Article
Language: ENGLISH
Abstract: The test methods for assessing environment assisted cracking of metals in aqueous solutions are described. The advantages and disadvantages are examined and the interrelationship between results from different test methods is discussed. The source of differences in susceptibility to cracking observed occasionally from the varied mechanical test methods is often the variation in environmental parameters between the different tests and the lack of adequate specification, monitoring, and control of environmental variables. Time is also a significant factor when comparing results from short term tests with long exposure tests. In addition to these factors, the intrinsic difference in the important mechanical variables, such as strain rate, associated with the various mechanical test methods can change the apparent sensitivity of the material to stress corrosion cracking. The increasing economic pressure for more accelerated testing is in conflict with the characteristic time dependence of corrosion processes. Unreliable results may be inevitable in some cases, but improved understanding of mechanisms and the development of mechanistically based models of environment assisted cracking which incorporate the key mechanical, material, and environmental variables can provide the framework for a more realistic interpretation of short term data. Graphs. 57 ref.
Descriptors: Journal Article; Stress corrosion tests; Stress corrosion cracking-- Environmental effects; Crack propagation-- Environmental effects ; Strain rate-- Environmental effects; Elongation-- Environmental effects; Corrosion fatigue-- Environmental effects; Corrosion environments
Section Headings: 35 (CORROSION)

63.

1567055 MA Number: 88-220444
The Effect of Frequency in Environmental Fatigue Tests.
Gabetta, G
CISE
Fatigue Fract. Eng. Mater. Struct. 10, (5), 373-383 1987 ISSN: 0160-4112
Journal Announcement: 8804
Document Type: ARTICLE
Language: ENGLISH
Abstract: The complex dependence of environmental fatigue crack growth rate on loading variables, has been studied for a pressure vessel steel (A533B) in a pure water environment. Attention has been focused on the frequency effect, which has been interpreted by using a superposition model. With this approach, the maximum expected crack growth rate can be quantitatively estimated as a function of frequency; critical Delta K values for the onset of stress corrosion fatigue can be calculated as a function of crack tip strain rate, which depends on applied load, load rise time and crack length. The approach has been verified by a comparison with experimental data from two laboratories. The agreement of data with the

prediction is quite good. 21 ref.--AA
Descriptors: High strength steels-- Mechanical properties; Pressure vessels-- Mechanical properties; Piping-- Mechanical properties; Fatigue tests; Fatigue life
Alloy Index(Identifier): A533B-- SAHS
Section Headings: 22 (TESTING AND CONTROL)

64.

267553 MA Number: 71-220851
METHOD OF SIMULATING THE GROWTH OF CRACKS IN LOW-CYCLE CORROSION FATIGUE
TESTING
KUDRYAVTSEV, I V ; CHEKNEV, A R
IND LAB JULY 1970, 36, --7--, 1063-1066.
Journal Announcement: 7109
Document Type: ARTICLE
Language: ENGLISH
Descriptors: ALLOY STEELS-- CORROSION; CARBON STEELS-- CORROSION; CORROSION FATIGUE; CORROSION TESTS; CRACK PROPAGATION
Section Headings: 22 (TESTING AND CONTROL)

65.

04225535 E.I. No: EIP95082816043
Title: Chloride-induced stress corrosion cracking of duplex stainless steels. Models, test methods and experience
Author: Kangas, P.; Nicholls, J.M.
Corporate Source: AB Sandvik Steel, Sandviken, Sweden
Source: Werkstoffe und Korrosion v 46 n 6 Jun 1995. p 354-365
Publication Year: 1995
CODEN: WSKRAT ISSN: 0043-2822
Language: English
Document Type: JA; (Journal Article) Treatment: X; (Experimental)
Journal Announcement: 9510W2
Abstract: Stress corrosion cracking (SCC) induced by chlorides frequently causes problems in applications where standard austenitic stainless steels are being used. Often this problem can be solved by the use of duplex stainless steels. In this report the mechanisms for SCC have been surveyed, and the cause for the high SCC resistance of duplex stainless steels has been discussed and evaluation of test methods for SCC and how duplex stainless steels respond to them, as well as practical experience of duplex stainless steels. The study shows that no single mechanism can be attributed to the good resistance to SCC of duplex stainless steels. Probably a synergistic effect of electrochemical and/or mechanical effects is responsible for the good performance. Test methods for SCC often give relatively good correspondence with real applications, but ranking is often doubtful, and comparisons of different material types should be made with caution. Numerous cases with SCC on standard austenitic stainless steels have been solved by the use of duplex stainless steels. (Author abstract) 35 Refs.
Descriptors: *Steel corrosion; Stress corrosion cracking; Stainless steel ; Chlorine; Corrosion resistance; Materials testing; Performance; Crack initiation; Crack propagation; Corrosion fatigue
Identifiers: Duplex stainless steel; Synergistic effect

Classification Codes:
539.1 (Metals Corrosion); 545.3 (Steel); 422.2 (Test Methods); 931.1 (Mechanics)
539 (Metals Corrosion & Protection); 545 (Iron & Steel); 804 (Chemical Products); 422 (Materials Testing); 931 (Applied Physics); 421 (Materials Properties)
53 (METALLURGICAL ENGINEERING); 54 (METAL GROUPS); 80 (CHEMICAL ENGINEERING); 42 (MATERIALS PROPERTIES & TESTING); 93 (ENGINEERING PHYSICS)

66.

01574579 E.I. Monthly No: EI8410099354 E.I. Yearly No: EI84003370
Title: ACCELERATION OF CORROSION TESTS OF THE STRUCTURAL ELEMENTS OF PASSENGER AIRPLANE FUSELAGES.
Author: Karlashov, A. V.; Gainutdinov, R. G.; Svintsitskii, A. M.; Voronkin, N. F.; Sadkov, V. V.; Voronov, V. F.; Krasnov, E. A.
Source: Soviet Materials Science (English Translation of Fiziko-Khimicheskaya Mekhanika Materialov) v 20 n 1 Jan-Feb 1984 p 81-82
Publication Year: 1984
CODEN: SOMSA4 ISSN: 0038-5565
Language: ENGLISH
Journal Announcement: 8410
Abstract: An attempt is made to establish the character of change in the corrosion acceleration factor in relation to the time of corrosion tests of structural elements of V95 aluminum alloy for passenger airplane fuselage. Aircraft structures are subjected to the action of not only atmospheric but also condensate moisture (condensate), which is quite an aggressive corrosive medium causing separation corrosion of the stringers of the subfloor portion of the fuselage. In our experiment the medium imitating the action of natural condensate was a model (artificial) one [6] imitating well the separation character of the corrosion of stringers and practically as aggressive as natural condensate. For accelerated tests a solution with 1. 0 g/liter of potassium bichromate and 1. 0 ml/liter of hydrochloric acid was selected. The experiments showed that in the solution selected for accelerated tests separation corrosion of the elements of stringers is reproduced sufficiently well. With an increase in corrosion time the fatigue life of the samples continuously decreases, especially sharply after the first 20-40 days. 8 refs.
Descriptors: *AIRCRAFT--*Fuselage; ALUMINUM AND ALLOYS--Corrosion
Identifiers: V95 ALUMINUM ALLOY; CORROSION TESTS
Classification Codes:
652 (Aircraft); 541 (Aluminum & Alloys); 539 (Metals Corrosion & Protection)
65 (AEROSPACE ENGINEERING); 54 (METAL GROUPS); 53 (METALLURGICAL ENGINEERING)

67.

02822941 INSPEC Abstract Number: A87017732, B87015537
Title: Effects of dynamic strain on crack tip chemistry. Vol.II: tests using an internally creviced tensile specimen
Issued by: Electr. Power Res. Inst., Palo Alto, CA, USA
Publication Date: 15 Aug. 1986 Country of Publication: USA 68 pp.
Report Number: EPRI-RD-4649

Availability: Res. Rep. Center, P.O. Box 50490, Palo Alto, CA 94303, USA
Language: English Document Type: Report (RP)
Treatment: Practical (P)
Abstract: A better understanding of the mechanisms of stress corrosion cracking and corrosion fatigue should lead to more-accurate predictions of crack propagation rates in susceptible power plant components. Laboratory tests using a unique stress corrosion crack model help clarify the role of dynamic straining on the chemistry of the crack tip environment. The results show that crack tip straining-a factor overlooked in previous models-can change the composition of the solution at the tip of the crack. Armed with this knowledge, utility engineers can determine whether the most cost-effective course of action is to run, repair, or retire the affected equipment.
Descriptors: corrosion fatigue; corrosion testing; crack-edge stress field analysis; power plants; stress corrosion cracking
Identifiers: stress corrosion cracking; corrosion fatigue; crack propagation rates; power plant components; dynamic straining; crack tip environment
Class Codes: A8140N (Fatigue, embrittlement, and fracture); A8160B (Metals and alloys); A8170 (Materials testing); B0590 (Materials testing); B8230 (Thermal power stations and plants)

68.

01408136 N82-13282
Fatigue tests with a corrosive environment
WILSON, R. N.
Royal Aircraft Establishment, Farnborough (England). Materials Dept.
CORPORATE CODE: R2785060
In AGARD Fatigue Test Methodology 20 p (SEE N82-13274 04-31)
Oct. 1981
LANGUAGE: English
COUNTRY OF ORIGIN: United Kingdom COUNTRY OF PUBLICATION: International Organization
DOCUMENT TYPE: CONFERENCE PAPER
DOCUMENTS AVAILABLE FROM AIAA Technical Library
OTHER AVAILABILITY: NTIS HC A12/MF A02
JOURNAL ANNOUNCEMENT: STAR8204
The techniques used to study the fatigue behavior of metals and alloys in vacuum, gas and liquid environments are outlined. The methods used to simulate service conditions in the laboratory are described and the variables which must be considered when planning a corrosion fatigue test programme are discussed. An attempt to control or eliminate some of the experimental variables is illustrated. The fatigue performance of a fully protected 1.5 dog bone aluminium alloy test piece which is prestressed at low temperature and exposed to a corrosive environment prior to fatigue testing in salt fog is evaluated. (E.A.K.)
SOURCE OF ABSTRACT/SUBFILE: NASA CASI
DESCRIPTORS: *FATIGUE TESTS; *METAL FATIGUE; *STRESS CORROSION CRACKING; CORROSION PREVENTION; STRUCTURAL STRAIN; TEST FACILITIES
SUBJECT CLASSIFICATION: 7539 Structural Mechanics (1975-)

69.

01304985 N81-12474
Manual for the AGARD-coordinated Corrosion Fatigue Cooperative Testing Program (CFCTP)
WANHILL, R. J. H.; DELUCCIA, J. J.
National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.
CORPORATE CODE: NE736790
May 1979 80P.
REPORT NO.: NLR-MP-79017-U
LANGUAGE: English
COUNTRY OF ORIGIN: Netherlands COUNTRY OF PUBLICATION: Netherlands
DOCUMENT TYPE: REPORT
DOCUMENTS AVAILABLE FROM AIAA Technical Library
OTHER AVAILABILITY: NTIS HC A05/MF A01
JOURNAL ANNOUNCEMENT: STAR8103
Specifications for corrosion fatigue tests for aerospace structural materials are presented. Detailed specifications for specimens, clamping in, electrohydraulic machines, cold box, pre-exposure chambers, corrosion fatigue salt spray cabinet, specimen storage and cleaning, test procedure, reporting, and flight simulation testing are given. (Author (ESA))
SOURCE OF ABSTRACT/SUBFILE: ESA
DESCRIPTORS: *AIRFRAME MATERIALS; *CORROSION TESTS; *FATIGUE TESTS; FASTENERS; FATIGUE (MATERIALS); FATIGUE TESTING MACHINES; FLIGHT SIMULATION ; GUST LOADS; INTERNATIONAL COOPERATION; NORTH ATLANTIC TREATY ORGANIZATION
(NATO); SPECIFICATIONS; SPECIMEN GEOMETRY
SUBJECT CLASSIFICATION: 7539 Structural Mechanics (1975-)

70.

796528 199702-R6-0079
Cyclic laboratory test methods to more closely simulate corrosion performance of Zincalume coated steel under atmospheric exposure conditions.
Walter, G W
CORPORATE SOURCE: BHP Research
CONFERENCE: Electrochemical Methods in Corrosion Research V. I., Sesimbra, Portugal, 5-8 Sept. 1994 JOURNAL: Materials Science Forum, 192-194, (1), 447-454 ISSN: 0255-5476
PUBL. DATE: 1995
Switzerland, 1995
COUNTRY OF PUBLICATION: Switzerland
JOURNAL ANNOUNCEMENT: 9702
DOCUMENT TYPE: Conference Paper
LANGUAGE: ENGLISH
ABSTRACT: Two laboratory corrosion test methods were developed to simulate field tests for atmospheric corrosion. Both methods employ an automatic wet/dry cycle controlled by a timer. The first is a pollution gas box (PGB) test in which laboratory air polluted with SO sub 2 flows through glass test chambers housing samples under investigation. The second test uses an automatic cyclic dipper, which is a long horizontal bar with samples attached. The cyclic dipper lowers and raises the samples into their respective solutions in separate beakers at intervals controlled by a timer. Although these conditions may be specific to these tests, the methods can be adopted for other accelerated laboratory corrosion tests.

The automatic cyclic dipper was tested for two applications. In one, three paint systems were evaluated for the extent of blistering at a sheared edge caused by undercutting. Two of the paints were with non-chromate primers while the third one had a standard chromate primer. One of the non-chromate primers had about the same amount of undercutting as the standard chromate primer control but the second non-chromate primer gave a poor performance. The other application of the automatic cyclic dipper showed the corrosion performance of 55% Al-Zn coated steel. A dramatic difference was observed between the cyclic and full immersion tests in chloride solution. The cyclic test was more representative of atmospheric conditions. The two laboratory test methods described here simulate corrosion performance under atmospheric conditions more closely than full immersion tests. Graphs. 16 ref.

DESCRIPTORS: Conference Paper; Steels-- Corrosion; Corrosion resistance-- Coating effects; Aluminum base alloys-- Coatings; Zinc-- Alloying elements ; Atmospheric corrosion; Air pollution; Blistering; Paints; Simulation; Immersion tests (corrosion)

SECTION HEADINGS: R6 (Corrosion/Electrochemistry/Chemical Reactions)

71.

770743 199311-R8-0281

Toward Better Quantitative Models for the Corrosion of Aluminum Using Fractal Geometry.

Trethewey, K R ; Keenan, J S ; Sargeant, D A ; Haines, S ; Roberge, P R

CORPORATE SOURCE: Royal Naval Engineering College (UK)

CONFERENCE: Light Metals Processing and Applications, Quebec City, Quebec, Canada, 29 Aug.-1 Sept. 1993 763-772

PUBL: Canadian Institute of Mining, Metallurgy and Petroleum, Xerox Tower, 1210-3400 Maisonneuve Blvd. W., Montreal, Quebec H3Z 3B8, Canada, 1993

COUNTRY OF PUBLICATION: Canada

JOURNAL ANNOUNCEMENT: 9311

DOCUMENT TYPE: Conference Paper

LANGUAGE: ENGLISH

ABSTRACT: The recently described principles of fractal geometry have been used to model changes to surface profile during corrosion of aluminium 2024. Fractal representations of both uncorroded and corroded surfaces have been modelled and correlated with traditional values of surface roughness parameters obtained using a Talysurf instrument. Scope for the extension of the technique to creation of improved quantitative models of localized attack is discussed. Graphs. 29 ref.

DESCRIPTORS: Conference Paper; Aluminum base alloys-- Corrosion; Pitting (corrosion); Geometry; Roughness; Profiles; Al Cu Mg Mn alloys

ALLOY INDEX(IDENTIFIER): 2024, Al-4.3Cu-1.5Mg-0.6Mn-- AL

SECTION HEADINGS: R8 (Processing/Modelling)

72.

765219 199305-R6-0195

Development of an Empirical Model for the Evaluation of Susceptibility of Stress Corrosion Cracking.

Bryson, G D ; Roberge, P R

CORPORATE SOURCE: Royal Military College of Canada

CONFERENCE: Materials Performance: Sulphur and Energy, Edmonton,

Alberta, Canada, 23-27 Aug. 1992 247-257
PUBL: Canadian Institute of Mining, Metallurgy and Petroleum, Xerox Tower, 1210-3400 de Maisonneuve Blvd. W., Montreal, Quebec H3Z 3B8, Canada, 1992
COUNTRY OF PUBLICATION: Canada
JOURNAL ANNOUNCEMENT: 9305
DOCUMENT TYPE: Conference Paper
LANGUAGE: ENGLISH
ABSTRACT: Stress corrosion cracking (SCC) is a common phenomenon often associated with the catastrophic failure by cracking in circumstances where, in the absence of corrosion, no failure would have been expected. Normally ductile alloys, such as brasses and steels, can display apparently brittle behaviour while high strength alloys can fail at stress intensities well below half the normal critical value. The process associated with SCC can vary widely in their basic mechanisms and not all of them are completely understood. Discussed is SCC in Al alloys. 14 ref.
DESCRIPTORS: Conference Paper; Aluminum base alloys-- Corrosion; Stress corrosion cracking; Stress intensity; Mathematical models; Tensile properties; Corrosion environments
SECTION HEADINGS: R6 (Corrosion/Electrochemistry/Chemical Reactions)

73.

751754 91-640222
Corrosion of Construction Metals Under Simulated Acid Rain/Fog Conditions With High Salinity.
Fang, H H P ; Wu, K K ; Yeong, C L Y
JOURNAL: Water, Air and Soil Pollution, 53, (3-4), 315-325 ISSN: 0049-6979
PUBL. DATE: 1990
JOURNAL ANNOUNCEMENT: 9109
DOCUMENT TYPE: ARTICLE
LANGUAGE: ENGLISH
ABSTRACT: Corrosion of 1312 specimens of five common construction metals and alloys was examined in a salt-spray chamber under simulated conditions of acid rain/fog with high salinity. When specimens were exposed to a condition simulating the acid rain/fog in summer in Hong Kong, with pH 3.5, 1% of salt, and 35 deg , the average corrosion rates were 735, 330, 2, 97 and 9 mu m/year, respectively for mild steel, galvanized steel, stainless steel 304, brass, and Al. Relative effects of pH, salt concentrate, and temperature on the corrosion were analyzed based on tests conducted at nine conditions. For four alloys, the corrosion rate increases linearly with increasing acidity, salinity, and temperature, according to regression analysis. Corrosion rate of SS 304 is almost independent of salinity and temperature, but is slightly affected by pH. Red brass is more susceptible than SS 304, but its susceptibilites to pH and salinity are one order of magnitude lower than those of mild steel and galvanized steel. Mild steel is about five times more susceptible to pH than galvanized steel, whereas the latter is approx 3 times more susceptible to salinity than the former. Aluminum corrosion rate increases with decreasing pH. The effects of salinity and temperature are inconclusive.--Chem. Abs.
DESCRIPTORS: Building components-- Corrosion; Atmospheric corrosion-- Environmental effects; Corrosion rate-- Environmental effects; Air pollution-- Corrosion environments; Marine atmospheres
SECTION HEADINGS: 64 (Corrosion)

74.

748292 91-640065

Modelling Acidic Corrosion of Aluminum Foil in Contact With Foods.

Piergiovanni, L ; Fava, P ; Ciappellano, S ; Testolin, G

CORPORATE SOURCE: University of Milan

JOURNAL: Packaging Technology & Science, 3, (4), 195-201 ISSN: 0894-3214

PUBL. DATE: Oct.-Dec. 1990

JOURNAL ANNOUNCEMENT: 9103

DOCUMENT TYPE: ARTICLE

LANGUAGE: ENGLISH

ABSTRACT: The possible interaction between non-coated Al and foods was studied using the corrosion behavior of an Al household foil under different conditions of acidity, dissolved oxygen and temperature of the contacting phase. The Al foil was kept in contact with acetic acid solutions of pH values varying from 2.5-3.5 and dissolved O concentrations between 0-8 ppm, under different conditions of temperatures (from 0.3-50 deg C) and contact time between 24-120 h. Corrosion was always detected, and it was shown that all three variables influence the rate, and consequently the extent, of the interaction, but pH and temperature have a greater effect since their relationships with rate are of an exponential nature. The relationship between corrosion rate and dissolved O, however, is linear and has a minor accelerating effect on the corrosion rate. By applying the Arrhenius equation it was possible to evaluate the thermal sensitivity of the phenomenon with respect to the different variables. The activation energies vary between 31-635 and 88-471 J mol exp --1 , indicating a higher thermal sensitivity at the lowest pH values and highest dissolved O amounts. Graphs. 5 ref.--AA(US).

DESCRIPTORS: US wrought alloy 8014-- Corrosion; Al Fe Mn wrought alloys-- Corrosion; Food packaging-- Corrosion; Aluminum foil-- Corrosion; Corrosion rate-- Environmental effects; Organic acids-- Corrosion environments

SECTION HEADINGS: 64 (Corrosion)

75.

740212 90-640118

Stress Corrosion Cracking Model in 7075 Aluminum Alloy.

Onoro, J ; Moreno, A ; Ranninger, C

CORPORATE SOURCE: ETS Ingenieros Industriales

JOURNAL: J. Mater. Sci., 24, (11), 3888-3891 ISSN: 0022-2461

PUBL. DATE: Nov. 1989

JOURNAL ANNOUNCEMENT: 9004

DOCUMENT TYPE: ARTICLE

LANGUAGE: ENGLISH

ABSTRACT: The stress corrosion cracking is a typical fracture process in metals and alloys. Among Al alloys, the 7075 alloy presents high performance in mechanical properties but it is susceptible to stress corrosion cracking. A semiempirical model of crack growth by stress corrosion cracking for the alloy is presented. This model only uses macroscopic parameters from fracture mechanic theory and experimental tests which are easy to obtain. The model quantifies the fissure rate related to environmental condition, microstructure and loading level, permitting the evaluation of the crack growth process at different environmental

conditions and heat treatments. The model results are compared wtih the experimental data obtained. The theoretical model reproduces adequately the stress corrosion cracking process for the 7075 alloy. . 7 ref.--AA(UK/US).
DESCRIPTORS: Span wrought alloy 7075-- Stress corrosion; Al Zn Mg Cu wrought alloys-- Stress corrosion; Stress corrosion cracking-- Models; Crack propagation-- Models; Mathematical models; Fracture mechanics
SECTION HEADINGS: 64 (Corrosion)

76.

738771 90-640028
Preventing Aircraft Corrosion by Predictive Corrosion Modeling. (Retroactive Coverage).
Miller, R N ; Meyer Jr, F H
CORPORATE SOURCE: Lockheed Georgia, AFWAL/MLSA
CONFERENCE: 1987 Tri-Service Conference on Corrosion. Vol. II, US Air Force Academy, Colorado, USA, 5-7 May 1987 359-384
PUBL: Air Force Wright Aeronautical Laboratories, Wright-Patterson AFB, Ohio 45433-6533, USA, 1987
REPORT NO.: AFWAL-TR-87-4139-II
JOURNAL ANNOUNCEMENT: 9002
DOCUMENT TYPE: CONFERENCE PAPER
LANGUAGE: ENGLISH
ABSTRACT: A US Air Force program to optimize aircraft maintenance scheduling through the use of a predictive corrosion model, which is based on the kinetics of corrosion reactions, the degradation rates of protective systems and the environmental conditions at Air Force bases is described. A VAX-11 FORTRAN computer program has been developed which enables the analysis of specific points on the C-5 aircraft and, utilizing environmental factors and the time periods an aircraft has been at various Air Force bases, gives recommended times for inspection and maintenance. The computer program includes a crack growth module which calculates the remaining flight hours until theoretical cracks grow to half their critical length, a corrosion module which computes the time for exposed aircraft alloys to corrode to a depth of 3 mils, and a coating degradation module which determines the optimum time until the next paint renewal or complete repaint operation. The predictive corrosion model, when completed, will be used to optimize field and depot level maintenance for aircraft now in operation, inspection and maintenance schedules for new aircraft, and selection of aircraft for analytical condition inspection. Alloys analyzed include magnesium base alloy AZ31B, Al base alloys 2024, 7075 and 7079 and steels 4340 and 300M. Graphs. 6 ref.--AA(US).
DESCRIPTORS: Al Cu Mg Mn wrought alloys-- Corrosion; Al Zn Mg Cu wrought alloys-- Corrosion; Aircraft components-- Corrosion; Corrosion prevention; Corrosion rate-- Computer simulation; Computer programs
SECTION HEADINGS: 64 (Corrosion)

77.

728472 88-640261
Model Experiments Concerning Mechanism of Stress-Corrosion Cracking of AlZnMg Alloys. (WAA Translation).
Ratke, V L ; Gruhl, W
JOURNAL: Werkst. Korros., 31, (10), 768-773 ISSN: 0043-2822
PUBL. DATE: Oct. 1980

JOURNAL ANNOUNCEMENT: 8811
DOCUMENT TYPE: ARTICLE
LANGUAGE: ENGLISH
ABSTRACT: Previously abstracted from original as item 8104-6.4-0119X. To clarify the SCC of AlZnMg alloys, tubes were filled with the corrosive medium and subjected to tensile stresses. To increase localized tension, circumferential notches were made. The formation of SCC fracture on the outside of the tubes can only be explained by hydrogen embrittlement. The equilibrium solubility of the grain boundary for hydrogen is dependent upon the value of the effective normal tensile stress. The grain boundary adhesive strength is reduced to the diffused H, producing a decohesive effect. This results in intercrystalline brittle fracture in the range of the elastic tension. 37 ref.--WAA Trans.(US).
DESCRIPTORS: Al Zn Mg wrought alloys-- Stress corrosion cracking; Stress corrosion cracking-- Mechanisms; Hydrogen embrittlement-- Mechanisms
SECTION HEADINGS: 64 (Corrosion)

78.

727596 88-480266
A Simulative Laboratory Test for Evaluation of Metallic Corrosion in Windy Coastal Atmosphere.
Chang, T -C ; I, Y ; Horng, Y -T
CORPORATE SOURCE: Ministry of Communication (Taiwan)
CONFERENCE: 10th International Congress on Metallic Corrosion. Vol. I: Sessions 1-4, Madras, India, 7-11 Nov. 1987 JOURNAL: Key Eng. Mater., 20-28, (1), 9-15 ISSN: 0252-1059
PUBL. DATE: 1988
JOURNAL ANNOUNCEMENT: 8810
DOCUMENT TYPE: CONFERENCE PAPER
LANGUAGE: ENGLISH
ABSTRACT: A two step laboratory test, salt spray after sand blast, was designed to simulate the windy coastal environment. This test was adopted to evaluate class A Zn-coated and Al-coated steel wire. The results showed that this two step test is a very effective accelerated laboratory corrosion test which can simulate the mutual action of sand abrasion and marine corrosion. Through this test, the Al-coated steel wire performs only 0.6 times better than Zn-coated steel wire. It was also found the erosive wear of Zn and Al coated steel wire fits the ductile-cutting model. 11 ref.--AA(US).
DESCRIPTORS: Aluminized steel-- Corrosion; Aluminum coatings-- Corrosion; Artificial weathering tests; Marine atmospheres
SECTION HEADINGS: 48 (Metallic Coating)

79.

196219 83-640216
Cavitation Erosion--Corrosion Modeling.
McGuinness, T ; Thiruvengadam, A
CORPORATE SOURCE: American Society for Testing and Materials
CONFERENCE: Erosion, Wear and Interfaces With Corrosion, Philadelphia, Pa., 24-29 June 1973 30-55
PUBL: American Society for Testing and Materials, 1916 Race St., Philadelphia, Pa. 19103, 1982
JOURNAL ANNOUNCEMENT: 8308

DOCUMENT TYPE: CONFERENCE PAPER
LANGUAGE: ENGLISH
ABSTRACT: Due to the increased occurrence of cavitation erosion in hydrodynamic systems operating in an ocean environment, there is a need to study the role of corrosion on the process of cavitation erosion. Previously, for noncorrosive systems, correlation of experimental data with the theory of erosion resulted in a time-scale modeling law of erosion. The changes in this scaling law due to corrosion were then investigated. Erosion time history data for HY-130, HY-80, SAE 1020 steels and Al 5086 H117 at several different erosion intensities in sea and distilled water were generated. Results indicated that the relative erosion rate curves for materials susceptible to corrosion were different and that the changes due to corrosivity increased with increasing erosion intensities. By coupling changes in corrosivity with maximum erosion rate increases, and times to the maximum rates, it is possible to make prototype performance predictions for either sea water or distilled water conditions. Qualitative relationships were found between the relative erosion rates and galvanic potentials of tested materials. A mechanism was proposed to account for the corrosive influence on erosion based on hydrogen-generated micropit destruction of a material surface that accelerates cavitation erosion. 35 ref.--AA.
DESCRIPTORS: US wrought alloy 5086-- Erosion corrosion; Al Mg Mn wrought alloys-- Erosion corrosion; Cavitation corrosion-- Mathematical models; Erosion corrosion-- Mathematical models; Erosion rate; Galvanic potential; Sea water-- Corrosion environments
SECTION HEADINGS: 64 (Corrosion)

80.

190700 82-640294
Mathematical Modeling of Exfoliation Corrosion in High-Strength Aluminum Alloys.
Robinson, M J
JOURNAL: Corros. Sci., 22, (8), 775-790
PUBL. DATE: 1982
JOURNAL ANNOUNCEMENT: 8210
DOCUMENT TYPE: ARTICLE
LANGUAGE: ENGLISH
ABSTRACT: A model for the formation of surface blisters was developed. The internal pressure of the blisters was calculated together with the dimensions that define the extent and the severity of the degradation. The effects of the elongated grain shape and of the heat treatment condition on exfoliation corrosion were investigated theoretically and found to compare favorably with experimental observations. Micrographs show blisters in L97 exposed to "EXCO" for 96 hr, with single and multiple layers of corrosion products and a fractured blister. Exfoliation damage may be minimized by reducing the aspect ratio of the grains or by overaging. Below a particular grain aspect ratio spalling, flaking or powdering occur rather than blistering. The depth of penetration of exfoliation corrosion depends on the susceptibility to intergranular corrosion but not the grain shape. 13 ref.--EAA/AF.
DESCRIPTORS: Exfoliation corrosion-- Mathematical models; Blistering-- Mechanisms; G Br wrought alloy L97-- Exfoliation corrosion; Al Cu Mg Mn wrought alloys-- Exfoliation corrosion; Exfoliation corrosion-- Crystal structural effects

SECTION HEADINGS: 64 (Corrosion)

81.

187815 82-640161
Initiation of Crevice Corrosion. Pt. 2. Mathematical Model for Aluminum in Sodium Chloride Solutions.
Alkire, R C ; Siitari, D
JOURNAL: J. Electrochem. Soc., 129, (3), 488-496
PUBL. DATE: Mar. 1982
JOURNAL ANNOUNCEMENT: 8205
DOCUMENT TYPE: ARTICLE
LANGUAGE: ENGLISH
ABSTRACT: See also preceding abstract. Salient features of initial stages of Al crevice corrosion in a dilute chloride solution have been expressed with mathematical equations to relate corrosion behavior to transport and electrochemical phenomena. The features included in the model equations are metal dissolution, metal-ion hydrolysis, oxygen reduction, diffusion along the crevice and ohmic resistance effects. The system of nonlinear differential equations was solved with a digital computer. Computations based on experiments described in the first part of this series were compared with experimental data including p H, potential and current distributions. Theoretical predictions of the time at which breakdown occurred were found to be about one-half of the initiation time observed experimentally. The calculations gave trends in system behavior which correctly tracked observations upon variation of crevice gap and solution conductivity, but not crevice depth. A critically important but highly uncertain feature of the model was the mechanism of passivity breakdown of Al in dilute chloride solution. Improved understanding of the breakdown mechanism would enhance predictive capabilities of the model. 18 ref.--AA.
DESCRIPTORS: Crevice corrosion-- Mathematical models; Sodium chloride-- Corrosion environments
SECTION HEADINGS: 64 (Corrosion)

82.

1943132 MA Number: 199706-22-0526
Improved measurements of samples simulating corrosion in lap-seams of aluminum aircraft.
Schmidt, W F ; Zinke, O H
University of Arkansas
Conference: Twenty-Second Symposium on Quantitative Nondestructive Evaluation, Seattle, 30 July-4 Aug. 1995
Publ: Plenum Publishing Corp., 233 Spring St., New York, NY 10013, USA, 1995
Review of Progress in Quantitative Nondestructive Evaluation 15B, 1733-1739 1995 ISSN: 0-306-45310-X
Country of Publication: USA
Journal Announcement: 9706
Document Type: Conference Paper
Language: ENGLISH
Abstract: The AC magnetic bridges offer technique for continuous electromagnetic scanning of surfaces and lap seams of the aging aluminum aircraft to detect material losses due to corrosion. Aim of this investigation is to determine effect of thickness of a conducting piece,

separating the faces of bridge in sample gap, and frequency on sensitivity of the bridge. Specimens of 6061 aluminum plates were used in experiments. Investigation was designed to determine optimum configuration of bridge insert thickness and frequency with which to operate the bridge for detection of material losses on aluminum lap seam. Clearly, there is no single combination of theses parameters. Selection of required parameters is necessary. Maps; Spectra. 6 ref.

Descriptors: Conference Paper; Aluminum base alloys-- Nondestructive testing; Plate metal-- Joining; Lap joints-- Corrosion; Electromagnetic testing; Scanning; Aircraft components-- End uses

Alloy Index(Identifier): 6061-- AL

Section Headings: 22 (TESTING AND CONTROL)

83.

1898978 MA Number: 199605-35-0843

Discussion of "a fully plastic microcracking model for transgranular stress corrosion cracking in planar slip materials" and reply.

Kaufman, M J ; Flanagan, W F ; Lichter, B D ; Zhu, M ; Wang, M

University of Florida

USA, 1996

Metallurgical and Materials Transactions A 27A, (3), 819-821 Mar. 1996

ISSN: 1073-5623/83

Country of Publication: USA

Journal Announcement: 9605

Document Type: Article

Language: ENGLISH

Abstract: Flangan et al., presented the results of some rather impressive experimental work on transgranular stress corrosion cracking (TGSCC) in materials that undergo planar slip. Based on their results on disordered Cu-25Au in 0.6 M NaCl, they concluded that the "cracking is fully plastic, that is, deformation accompanies cracking such that the nominal stress on the uncracked cross section is maintained at the flow stress". They went on to conclude that "the mechanism of TGSCC is cleavage cracking accompanied by plasticity". The purpose here is to point out that most, if not all, of their results appear to be fully compatible with the localized ductile fracture mechanism presented by Kaufman and Fink (KF) in 1988. Unfortunately, this mechanism was neither discussed nor referred to in the Flanagan et al. article in spite of the fact that it is entirely supportive of the role of plastic deformation in the cracking process. Specifically, it was pointed out in the KF paper that TGSCC is a ductile fracture process which becomes highly localized by the environment. Thus, the main difference between the models is that KF suggested that the actual cracking process is not by cleavage as Flanagan et al. proposed. Graphs. 30 ref.

Descriptors: Journal Article; Copper base alloys-- Corrosion; Stress corrosion cracking; Transgranular corrosion-- Stress effects; Crack initiation-- Stress effects; Ductile fracture-- Stress effects; Plastic deformation-- Stress effects; Slip-- Stress effects

Alloy Index(Identifier): Cu-25Al-- CU

Section Headings: 35 (CORROSION)

84.

1736556 MA Number: 199203-35-0572

Laboratory Simulation of Atmospheric Corrosion by SO sub 2 . II.

Electrochemical Mass Loss Comparisons.
Walter, G W
BHP Steel
Corrosion Science 32, (12), 1353-1376 Dec. 1991 ISSN: 0010-938X
Country of Publication: UK
Journal Announcement: 9203
Document Type: Article
Language: ENGLISH
Abstract: Mass losses of Zn, steel and rolled Zn--55% Al alloy over the range 0-1 ppm [SO exp 2], obtained by weighing, or calculated using atmospheric corrosion monitors, ACMs, from galavanic current, I sub g , charge-transfer resistance. R sub t , polarization resistance, R sub p , or corrosion current, I sub k have been compared. The ability of Zn and Zn--55% Al alloy coatings to protect steel under these conditions is discussed. Although similar trends in mass loss vs. [SO sub 2] are generally apparent for each of the methods of obtaining mass loss, there are differences in the magnitude of mass loss, which in some cases are substantial. The reasons for these differences are discussed in detail. One reason, that of partial short circuits between adjacent ACM plates in the presence of [SO sub 2], thought due to electron-conducting corrosion products, leads to high values of calculated mass loss. Partial short circuits appear to occur at random and may or may not occur in apparently identical tests for ACM3 (Zn) and ACM8 (Fe) but no ACM4 (rolled Zn--55% Al). The effect of these partial short circuits can be modelled by inclusion of a corrosion product resistance, R sub cp , in parallel with R sub t and Warburg impedance, Z sub omega . The scope of the work with these ACMs is wider than previous work in the literature. This includes a modified method of manufacture; a more sophisticated method of measuring ACM corrosion currents; and a wider correlation of electrochemically calculated mass loss with weighed mass loss. Graphs. 25 ref.
Descriptors: Journal Article; Steels-- Corrosion; Aluminum base alloys-- Coatings; Zinc-- Coatings; Atmospheric corrosion; Galvanic corrosion tests ; Sulfur dioxide-- Environment; Electrochemistry; Weight loss measurement; Monitoring
Section Headings: 35 (CORROSION)

85.

1736555 MA Number: 199203-35-0571
Laboratory Simulation of Atmospheric Corrosion by SO sub 2 . I. Apparatus, Electrochemical Techniques, Example Results.
Walter, G W
BHP Steel
Corrosion Science 32, (12), 1331-1352 Dec. 1991 ISSN: 0010-938X
Country of Publication: UK
Journal Announcement: 9203
Document Type: Article
Language: ENGLISH
Abstract: The atmospheric corrosion by SO sub 2 has been simulated in the laboratory using a pollution gas box, PGB, which is described. Both two-electrode galvanic cell type atmospheric corrosion monitors, ACMs (Zn/Fe, cast Zn--55% Al/Fe, rolled Zn--55% Al/Fe), and three-electrode electrochemical cell type ACMs (Zn, Fe, cast Zn--55% Al, rolled Zn--55% Al) have been constructed using techniques modified from those available in the literature. Techniques for carrying out PGB experiments on metal samples in

flowing laboratory air containing 0-1 ppm [SO sub 2] are described. Techniques for weighed sample mass loss and ACM electrochemical tests (galvanic current, impedance, corrosion current) are given along with examples of typical electrochemical results. Methods for calculating mass loss from these electrochemical tests are indicated. Graphs. 46 ref.

Descriptors: Journal Article; Galvanized steels-- Corrosion; Coatings-- Corrosion; Zinc-- Coatings; Aluminum-- Coatings; Zinc base alloys-- Coatings; Aluminum base alloys-- Coatings; Atmospheric corrosion; Sulfur dioxide-- Environment; Galvanic corrosion tests; Impedance; Monitoring; Weight loss measurement; Mathematical analysis

Section Headings: 35 (CORROSION)

86.

650746 MA Number: 79-310172

A Unified Model for Hydrogen Embrittlement, Liquid Metal Embrittlement and Temper Embrittlement Due to Weakening of Atomic Bonds.

Tetelman, A S ; Kunz, S

Conference: Stress Corrosion Cracking and Hydrogen Embrittlement of Iron Base Alloys, Unieux-Firminy, France, 12-16 June 1973

Publ: National Assoc. of Corrosion Engineers, Houston, Tex., 1977

359-375

Journal Announcement: 7901

Document Type: BOOK

Language: ENGLISH

Abstract: Differences in the form of data available for H embrittlement and for liquid metal embrittlement are discussed. Data are given on temp. dependence for H embrittlement, occurrence of liquid metal embrittlement for of metals, discontinuous crack growth, relation of embrittlement to partial molar heat of solution in solvent (H), and intermetallic compound strengths. It is concluded that H literature values can be used to predict H embrittlement, liquid metal embrittlement and temp. embrittlement.46 refs.--J.W.S.

Descriptors: Mathematical models; Hydrogen embrittlement; Temper brittleness; Liquid metals-- Diffusion; Crack propagation; Heat of solution

Alloy Index(Identifier): 4340-- SANCM/ 2024-- AL

Section Headings: 31 (MECHANICAL PROPERTIES)

87.

466006 MA Number: 75-350949

Simulated Crevice Corrosion Experiment for pH and Solution Chemistry Determinations.

Marek, M ; Hochman, R F

Corrosion June 1974, 30, (6), 208-210.

Journal Announcement: 7507

Document Type: ARTICLE

Language: ENGLISH

Descriptors: Aluminum base alloys-- Corrosion; Titanium base alloys-- Corrosion; Austenitic stainless steels-- Corrosion; Mercury amalgams-- Corrosion; Corrosion resistance

Alloy Index(Identifier): 316-- SSA/ 6061-- AL/ Ti-8Al-1Mo-1V-- TI

Section Headings: 35 (CORROSION)

88.

451526 MA Number: 75-350023
Statistical Model of Size Distribution of Pittings During Atmospheric Corrosion of Al Alloys.
Flaks, V Ya
Prot Met July-Aug. 1973, 9, (4), 407-409.
Journal Announcement: 7501
Document Type: ARTICLE
Language: ENGLISH
Descriptors: Aluminum base alloys-- Corrosion; Pitting (corrosion)
Alloy Index(Identifier): AVM-- AL/ AMg2M-- AL/ AMg3M-- AL/ AMg5M-- AL/ AMtsM-- AL
Section Headings: 35 (CORROSION)

89.

418307 MA Number: 74-350971
Mechanical Nature of Stress-Corrosion Cracking in Al-Zn-Mg Alloys. Pt. 2. Electrochemical-Mechanical Model.
Gerberich, W W ; Wood, W E
Metall Trans June 1974, 5, (6), 1295-1304.
Journal Announcement: 7409
Document Type: ARTICLE
Language: ENGLISH
Descriptors: Aluminum base alloys-- Corrosion; Stress corrosion cracking; Crack propagation-- Stress effects; Activation energy; Precipitate free zone
Alloy Index(Identifier): 7075-- AL
Section Headings: 35 (CORROSION)

90.

5280596 INSPEC Abstract Number: A9613-8160B-018
Title: A model for alloy film corrosion and prediction of resulting passive layer structures
Author(s): Cocke, D.L.; Dorris, K.; Naugle, D.G.; Hess, T.R.
Author Affiliation: Dept. of Chem., Lamar Univ., Beaumont, TX, USA
Conference Title: Proceedings of the Third International Symposium on Corrosion and Reliability of Electronic Materials and Devices p.358-65
Editor(s): Comizzoli, R.B.; Frankenthal, R.P.; Sinclair, J.D.
Publisher: Electrochem. Soc, Pennington, NJ, USA
Publication Date: 1994 Country of Publication: USA ix+417 pp.
Material Identity Number: XX95-02952
Conference Title: Proceedings of Third International Symposium on Corrosion Reliability of Electronic Materials and Devices
Conference Date: 9-14 Oct. 1994 Conference Location: Miami Beach, FL, USA
Language: English Document Type: Conference Paper (PA)
Treatment: Practical (P); Theoretical (T); Experimental (X)
Abstract: A new model that provides insight into alloy corrosion and allows for prediction of the resulting passive layer structures has been developed by considering the oxidation process as an electrochemical cell which includes the anodic reaction at the metal-oxide interface. The model includes composition of the alloy. Ti-Cu and Ti-Al alloys are discussed to illustrate the qualitative agreement with the model. (23 Refs)
Descriptors: aluminium alloys; copper alloys; corrosion; electrochemistry

; metallic thin films; oxidation; surface chemistry; titanium alloys
Identifiers: alloy film corrosion model; passive layer structure prediction; alloy corrosion; passive layer structure; oxidation process; electrochemical cell; anodic reaction; metal-oxide interface; Ti-Cu alloy; Ti-Al alloy; alloy composition; TiCu-Cu; TiAl-Cu; Cu
Class Codes: A8160B (Surface treatment and degradation of metals and alloys); A8245 (Electrochemistry and electrophoresis); A8265 (Surface chemistry); A6860 (Physical properties of thin films, nonelectronic)
Chemical Indexing:
TiCu-Cu int - TiCu int - Cu int - Ti int - TiCu bin - Cu bin - Ti bin - Cu el (Elements - 2,1,2)
TiAl-Cu int - TiAl int - Al int - Cu int - Ti int - TiAl bin - Al bin - Ti bin - Cu el (Elements - 2,1,3)
Cu sur - Cu el (Elements - 1)

91.

4807748 INSPEC Abstract Number: B94I2-7620-017
Title: Pulsed eddy-current characterization of corrosion in aircraft lap splices: Quantitative modeling
Author(s): Rose, J.H.; Uzal, E.; Moulder, J.C.
Author Affiliation: Center for Nondestructive Evaluation, Iowa State Univ., Ames, IA, USA
Journal: Proceedings of the SPIE - The International Society for Optical Engineering vol.2160 p.164-76
Publication Date: 1994 Country of Publication: USA
CODEN: PSISDG ISSN: 0277-786X
U.S. Copyright Clearance Center Code: 0 8194 1455 7/94/$6.00
Conference Title: Superconductive Devices and Circuits
Conference Sponsor: SPIE
Conference Date: 25-27 Jan. 1994 Conference Location: Los Angeles, CA, USA
Language: English Document Type: Conference Paper (PA); Journal Paper (JP)
Treatment: Theoretical (T)
Abstract: Pulsed eddy-current detection and characterization of wall-thinning in aircraft lap-splices due to corrosion is studied theoretically. The relevant lap-splices consist of two one millimeter thick sheets of aluminum bonded together by bolts and separated a small distance by an insulating sealant. Corrosion changes the thickness of both plates and the size of the gap between them. The problem is to determine nondestructively the thickness of both the "top" and "bottom" plates as well as the intervening gap. We calculate the time-domain current-voltage response function of a small cylindrically symmetric coil of wire that is placed next to a lap joint and excited by a step-function current. The result for air-core coils is obtained as a simple quadrature, while coils that contain ferrite-cores are modeled with a finite element code. The characteristic features of the transient response are shown to depend sensitively on the thickness of the top plate, the gap and the bottom plate. (9 Refs)
Descriptors: aerospace testing; aircraft; aluminium; coils; corrosion testing; eddy current testing; finite element analysis; flaw detection; frequency-domain analysis; time-domain analysis
Identifiers: pulsed eddy-current characterization; pulsed eddy-current

detection; corrosion; aircraft lap splices; quantitative modeling; wall-thinning; aluminum sheets; insulating sealant; plate thickness; gap size; nondestructive determination; time-domain current-voltage response function; cylindrically symmetric wire coil; step-function current; air-core coils; quadrature; ferrite-core coils; finite element modelling; transient response; Al

Class Codes: B7620 (Aerospace test facilities and simulation); B0590 (Materials testing); B0290T (Finite element analysis); B0220 (Analysis)

Chemical Indexing:

Al el (Elements - 1)

92.

00330129 A69-36897

The mechanism of stress corrosion cracking in 7075 aluminum. (Stress corrosion cracking model for 7075 Al, correlating macroscopic yield stress and corrosion time to failure)

JACOBS, A. J. /NORTH AMERICAN ROCKWELL CORP., ROCKETDYNE DIV., CANOGA PARK, CALIF./.

PLACE OF PUBLICATION: HOUSTON, TEX. PUBLISHER: NATIONAL ASSN. OF CORROSION ENGINEERS 1969 31P. 45 REFS.

PUBLICATION NOTE: CONFERENCE SPONSORED BY THE U.S. AIR FORCE, THE U.S. ATOMIC ENERGY COMMISSION, AND THE U.S. NAVY.

PRESENTATION NOTE: IN- FUNDAMENTAL ASPECTS OF STRESS CORROSION CRACKING, PROCEEDINGS OF THE CONFERENCE, OHIO STATE U., COLUMBUS, OHIO, SEP. 11-15, 1967. P. 530-560. /A69-36883 19-17/

CONTRACT NO.: NAS7-162; NOW-66-0309-D

LANGUAGE: English

COUNTRY OF ORIGIN: United States COUNTRY OF PUBLICATION: United States

DOCUMENT TYPE: CONFERENCE PAPER

DOCUMENTS AVAILABLE FROM AIAA Technical Library

JOURNAL ANNOUNCEMENT: IAA6919

SOURCE OF ABSTRACT/SUBFILE: AIAA

DESCRIPTORS: *ALUMINUM; *CRACKING (FRACTURING); *DYNAMIC MODELS; *STRESS CORROSION; *YIELD POINT; CONFERENCES; CRACK INITIATION; PERFORMANCE PREDICTION; TENSILE STRESS

SUBJECT CLASSIFICATION: 6517 Materials, Metallic (1965-74)

93.

12291780 PASCAL No.: 95-0524280

Activation energy in the modeling of complex and poorly known physicochemical processes in corrosion

SANTARINI G

CEA/DTA/CEREM/DECM, serv. corrosion elecrochimie chimie fluides, 92265 Fontenay-aux-Roses, France

Journal: Corrosion : (Houston, Tex.), 1995, 51 (9) 698-710

ISSN: 0010-9312 CODEN: CORRAK Availability: INIST-5595; 354000054660740060

No. of Refs.: 9 ref.

Document Type: P (Serial) ; A (Analytic)

Country of Publication: USA

Language: English

The concept of activation energy is used often as a guide in studies intended to elucidate mechanisms of complex corrosion phenomena, but it is

a concept prone to misinterpretation. In the present work, the limits of deductions based on activation energy were studied. It was shown that, if sufficient care is taken, comparisons of activation energies can help in the search for a rate law expressed in terms of relevant physicochemical parameters.

English Descriptors: Localized corrosion; Corrosion mechanism; Activation energy; Modeling; Physicochemical properties; Stress corrosion cracking; Corrosion rate; Inconel 600; Application; Nuclear reactor; Nickel base alloys

94.

36/5/220 (Item 1 from file: 32)

DIALOG(R)File 32:METADEX(R)

1944643 MA Number: 199707-22-0575

Comparison of accelerated and atmospheric exposure tests for corrosion of aluminium alloys.

de Damborenea, J ; Conde, A

Centro Nacional de Investigaciones Metalurgicas (Spain)

British Corrosion Journal 30, (4), 292-296 1995 ISSN: 0007-0599

Journal Announcement: 9707

Document Type: Article

Language: ENGLISH

Abstract: Two Al-Cu alloys (2024-T4 and 7075-T7351) and two Al-Li alloys (2091-T84 and 8090-T8171) were exposed for two years in a moderately aggressive marine environment and their corrosion behaviour was compared with that in accelerated test for intergranular corrosion (AIR 9048 and MIL H-6088F) and exfoliation (ASTM G-34). Exfoliation tests using solutions modified by previous exposure to the test solution until a constant pH was obtained were also carried out with the two Al-Li alloys. Although the accelerated tests do produce the type of attack intended, the results in the aggressive exco solutions do not agree well with those from outdoor exposure, even using the modified solutions. Graphs; Photomicrographs. 10 ref.

Descriptors: Journal Article; Aluminum base alloys-- Corrosion; Accelerated tests; Atmospheric corrosion tests; Marine environments; Intergranular corrosion; Exfoliation corrosion

Alloy Index(Identifier): 2024-- AL/ 7075-- AL/ 2091-- AL/ 8090-- AL

Section Headings: 22 (TESTING AND CONTROL); 35 (CORROSION)

95.

796276 199702-P7-0070

Accelerated corrosion testing. II. Description of three test methods.

Forshee, A G

CORPORATE SOURCE: Boeing

JOURNAL: Metal Finishing, 91, (12), 35-38 ISSN: 0026-0576

PUBL. DATE: Dec. 1993

USA, 1993

COUNTRY OF PUBLICATION: USA

JOURNAL ANNOUNCEMENT: 9702

DOCUMENT TYPE: Article

LANGUAGE: ENGLISH

ABSTRACT: Three promising accelerated test methods (Tafel plot extrapolation, cathodic breakdown test and AC impedance) for corrosion evaluation were identified following preliminary screening of 20 possible techniques. The Tapfel plot extrapolation results (TPE) did not correlate suitably to salt spray results so this test method was abandoned. AC impedance testing required fairly expensive test equipment and involved rather tedious frequency measurements which were sensitive to test sample configurations, so this method was also terminated to concentrate upon the cathodic breakdown test (CBT). This test was rapid, relatively simple and results correlated reasonably to salt spray pass/fail tests (5 or more pits on 3-in x 10-in 2024-T3 Al test panels). The cathode breakdown test (CBT) consists of measuring the time required to reach a current of 3 ma or 10 minutes for a standard applied voltage and test configuration (with a time greater than 10 min considered as passing). Graphs. 7 ref.
DESCRIPTORS: Journal Article; Aluminum-- Coating; Corrosion resistance-- Coating effects; Corrosion tests; Anodizing
SECTION HEADINGS: P7 (Surface Treatment/Coating)

96.

790432 199605-R7-0120
Exfoliation corrosion testing of aluminium alloys.
Braun, R
CORPORATE SOURCE: Institut fur Werkstofforschung
JOURNAL: British Corrosion Journal, 30, (3), 203-208 ISSN: 0007-0599
PUBL. DATE: 1995
UK, 1995
COUNTRY OF PUBLICATION: UK
JOURNAL ANNOUNCEMENT: 9605
DOCUMENT TYPE: Article
LANGUAGE: ENGLISH
ABSTRACT: The exfoliation corrosion behaviour of sheet and plate materials of various conventional Al and Al-Li alloys has been evaluated using accelerated tests. Results are compared with atmospheric exposure data published in the literature to assess the applicability of the testing techniques employed. For damage tolerant Al-Li based sheet and plate, the cyclic acidified salt fog (Mastmaasis) test according to ASTM G85, Annex A2 indicated susceptibility to exfoliation corrosion, reproducing the limited outdoor corrosion data for the Al-Li alloys 8090-T81 and 2091-T84 as well as marine exposure results reported for the conventional alloys 2024-T351 and 7075-T7351. Therefore, it appears to be a promising testing technique for predicting the service performance of high strength Al alloys. Compared with the ratings determined following the cyclic acidified salt fog tests, the standard Exco test according to ASTM G34 indicated better exfoliation corrosion behaviour of the alloys investigated, except for 8090-T6 sheet and 7075-T7351 plate, which exhibited severe and mild exfoliation respectively. In the modified Exco test suggested by Lee and Lifka (1992), 7075-T7351 panels were susceptible to pitting, whereas the other alloys studied generally suffered more severe exfoliation than in the standard Exco test. Graphs. 14 ref.
DESCRIPTORS: Journal Article; Aluminum base alloys-- Corrosion; Lithium-- Alloying elements; Exfoliation corrosion; Accelerated tests; Corrosion tests; Atmospheric corrosion; Pitting (corrosion); Al Li alloys; Al Cu Mg Mn alloys; Al Cu Li Mg Zr alloys; Al Zn Mg Cu alloys; Al Li Cu Mg alloys
ALLOY INDEX(IDENTIFIER): 2024-- AL/2091-- AL/7075-- AL/8090-- AL

SECTION HEADINGS: R7 (Testing/Analysis/Measurement/Metallography)

97.

788851 199603-R6-0102
Test method and test results for environmental assessment of aircraft materials.
Pourbaix, A
CORPORATE SOURCE: Belgian Center for Corrosion Study (Brussels)
CONFERENCE: Corrosion Detection and Management of Advanced Airframe Materials, Seville, Spain, 5-6 Oct. 1994 Pp 4
PUBL. DATE: Jan. 1995
1995
REPORT NO.: Paper 13
JOURNAL ANNOUNCEMENT: 9603
DOCUMENT TYPE: Conference Paper
LANGUAGE: ENGLISH
ABSTRACT: A study was conducted to identify whether life prediction of high strength aluminum alloys for aircrafts can be determined from short term accelerated atmospheric corrosion tests. The method used is a wet and dry method with electrochemical measurements to characterise the formation or destruction of passive layers. The materials tested include high strength steel 4130, precipitation hardening 15-7 Mo-PH steel and aluminium alloys 6061, 7075 and 2024 with different heat treatments and surface conditions. It appears that the ranking of different Al alloys depends on the type of atmosphere (chloride and acid). The method also clearly showed the detrimental effects of chromated cadmium plating on the hydrogen embrittlement of high strength steel. Corrosion processes of Al and high strength steels were clearly identified and useful recommendations could be derived from such tests. Graphs. 2 ref.
DESCRIPTORS: Conference Paper; Aluminum base alloys-- Corrosion; Precipitation hardening steels-- Corrosion; Chromium molybdenum steels-- Corrosion; Aircraft components-- Corrosion; Atmospheric corrosion; Hydrogen embrittlement; Corrosion tests; Al Mg Si Cu alloys; Al Zn Mg Cu alloys; Al Cu Mg Mn alloys
ALLOY INDEX(IDENTIFIER): 6061-- AL/7075-- AL/2024-- AL
SECTION HEADINGS: R6 (Corrosion/Electrochemistry/Chemical Reactions)

98.

788161 199602-R7-0046
Accelerated and real-time corrosion testing of aluminium-lithium alloys.
Schra, L
CORPORATE SOURCE: National Aerospace Laboratory (Netherlands)
CONFERENCE: Sixth International Aluminium-Lithium Conference, Garmisch-Partenkirchen, Germany, 7-11 Oct. 1991 JOURNAL: Aluminium-Lithiu m. Vol. 1 & 2, 813-818 ISSN: 3-88355-180-5
PUBL. DATE: 1992
PUBL: Deutsche Gesellschaft fur Materialkunde e.V., Adensauerallee 21, Oberursel 1, 6370, Germany, 1992
COUNTRY OF PUBLICATION: Germany
JOURNAL ANNOUNCEMENT: 9602
DOCUMENT TYPE: Conference Paper
LANGUAGE: ENGLISH
ABSTRACT: An investigation of corrosion, stress corrosion cracking (SCC)

initiation and SCC growth properties of Al-Li and conventional 2000 series plate and sheet alloys has shown that alloy rankings can depend on the type of test and environment. Extensive testing in realistic environments-- as far as possible--is therefore necessary, as well as accelerated laboratory tests, until a broad comparative database is obtained. Also, this kind of testing should be considered at an early stage in alloy evaluation programmes, even though priority is often given to other properties such as strength, fracture toughness and fatigue resistance. Graphs. 10 ref.

DESCRIPTORS: Conference Paper; Aluminum base alloys-- Corrosion; Lithium -- Alloying elements; Copper-- Alloying elements; Magnesium-- Alloying elements; Stress corrosion cracking; Atmospheric corrosion tests; Accelerated tests; Al Li Cu Mg alloys; Al Cu Mg Mn alloys; Al Cu Mg alloys; Al Cu Li Mg Zr alloys

ALLOY INDEX(IDENTIFIER): 8090-- AL/2024-- AL/2324-- AL/2091-- AL

SECTION HEADINGS: R7 (Testing/Analysis/Measurement/Metallography)

99.

787369 199601-R6-0015

Corrosion test selection for aluminum autobody sheet with chromium-free pretreatments.

Snodgrass, J S ; Weir, J R

CORPORATE SOURCE: Reynolds Metals

CONFERENCE: Corrosion and Corrosion Control of Aluminum and Steel in Lightweight Automotive Applications, Orlando, FL, USA, 26-31 Mar. 1995 380/1-380/11 ISSN: 1-877914-88-6

PUBL. DATE: 1995

PUBL: National Association of Corrosion Engineers, 1440 South Creek Dr., Houston, TX 77084, USA, 1995

COUNTRY OF PUBLICATION: USA

JOURNAL ANNOUNCEMENT: 9601

DOCUMENT TYPE: Conference Paper

LANGUAGE: ENGLISH

ABSTRACT: This paper describes a test program that used three corrosion tests to rank the relative durability of four Al autobody sheet alloys (2010, 2036, 5454 and 6111), each with six pretreatments. All three corrosion tests produced similar rankings of alloys and pretreatments. The need for additional work to correlate these rankings with field service experience is discussed. Graphs. 6 ref.

DESCRIPTORS: Conference Paper; Aluminum base alloys-- Corrosion; Automotive bodies; Surface pretreatments; Salt water-- Environment; Accelerated tests; Corrosion mechanisms; Al Mg Si alloys; Al Mg Mn alloys; Al Cu Mg Mn alloys; Al Cu Si alloys

ALLOY INDEX(IDENTIFIER): 6111-- AL/5454-- AL/2036-- AL/2010-- AL

SECTION HEADINGS: R6 (Corrosion/Electrochemistry/Chemical Reactions)

100.

787366 199601-R6-0012

Cosmetic corrosion of painted aluminum and steel automotive body sheet: results from outdoor and accelerated laboratory test methods.

Moran, J P ; Ziman, P R ; Egbert, M W

CORPORATE SOURCE: Alcoa

CONFERENCE: Corrosion and Corrosion Control of Aluminum and Steel in Lightweight Automotive Applications, Orlando, FL, USA, 26-31 Mar. 1995

374/1-374/22 ISSN: 1-877914-88-6
PUBL. DATE: 1995
PUBL: National Association of Corrosion Engineers, 1440 South Creek Dr., Houston, TX 77084, USA, 1995
COUNTRY OF PUBLICATION: USA
JOURNAL ANNOUNCEMENT: 9601
DOCUMENT TYPE: Conference Paper
LANGUAGE: ENGLISH
ABSTRACT: In recent years, increasing attention has been given to the need to develop an accelerated laboratory test method(s) for cosmetic corrosion of painted panels that realistically simulate in-service exposure. Much of that work has focused on steel substrates. The purpose of this research is to compare the corrosion performance of painted Al and steel sheet as determined from various laboratory methods and in-service exposure, and to develop a realistic accelerated test method for evaluation of the cosmetic corrosion of painted Al. Several Al sheet products from the 2xxx, 5xxx, and 6xxx alloy series have been tested. The steel substrates are similar to those used in other programs. The test methods chosen represent a cross-section of methods common to the automotive and Al industries for evaluation of painted sheet metal products. The results indicate that there is considerable difference in the relative correlation of various test methods to in-service exposure. In addition, there is considerable difference in the relative magnitudes and morphologies of corrosion, and occasionally in the relative rankings, as a function of test method. The influence of alloy composition and zinc phosphate coating weight are also discussed. Graphs. 12 ref.
DESCRIPTORS: Conference Paper; Aluminum base alloys-- Corrosion; Carbon steels-- Corrosion; Automotive bodies-- Corrosion; Phosphate coatings; Atmospheric corrosion tests; Accelerated tests; Filiform corrosion; Marine environments; Al Cu alloys; Al Si Mg Mn alloys; Al Mg Si alloys
ALLOY INDEX(IDENTIFIER): 2008-- AL/6009-- AL/6111-- AL
SECTION HEADINGS: R6 (Corrosion/Electrochemistry/Chemical Reactions)

101.

786655 199512-R6-0432

Influence of galvanic macro-cell-corrosion on the cavitation erosion durability assessment of metallic materials: international cavitation erosion test of Gdansk.

Sakamoto, A ; Funaki, H ; Matsumura, M
CORPORATE SOURCE: Hiroshima University
JOURNAL: Wear, 186-187, (8), 542-547 ISSN: 0043-1648
PUBL. DATE: Aug. 1995
Switzerland, 1995
COUNTRY OF PUBLICATION: Switzerland
JOURNAL ANNOUNCEMENT: 9512
DOCUMENT TYPE: Article
LANGUAGE: ENGLISH
ABSTRACT: Cavitation erosion tests were carried out on five metallic materials, Al, brass, Armco iron, carbon steel, and stainless steel, which are the standard materials of the International Cavitation Erosion Test Program which is coordinated by Dr. J. Steller, Institute of Fluid-Flow Machinery, the Polish Academy of Science, Gdansk, Poland. Three kinds of tesing apparatus were used: a vibratory unit, a vibratory unit with a stationary specimen, and a water tunnel. In the two vibratory tests, the

ranking order of the materials according to their durability to cavitation attack showed a complete coincidence with each other. However, the ranking based on the water tunnel test was different from those of the vibratory units. This was because the damage rate of some materials was suddenly accelerated in the middle of the water tunnel test. It was revealed that the remote cause of the sudden increase in erosion rate is the activation of damaged surface in atomic level, which promotes corrosion only when a macro-cell of corrosion is formed between the cavitation damaged area (anode) and the undamaged area (cathode). Thus is was pointed out that some undamaged area is some times necessary on laboratory test specimens when an accurate simulation of the cavitation damage in the field is demanded. Graphs. 8 ref.

DESCRIPTORS: Journal Article; Aluminum-- Corrosion; Brasses-- Corrosion; Carbon steels-- Corrosion; Ferrous alloys-- Corrosion; Stainless steels-- Corrosion; Cavitation; Erosion; Erosion rate

SECTION HEADINGS: R6 (Corrosion/Electrochemistry/Chemical Reactions)

102.

786632 199512-R6-0409

Cyclic corrosion tests in Japanese industries.

Suga, S

CORPORATE SOURCE: Suga Test Instruments

CONFERENCE: Cyclic Cabinet Corrosion Testing, Dallas, TX, USA, 14-19 Nov. 1993 99-112 ISSN: 0-8031-2014-1

PUBL. DATE: 1995

PUBL: ASTM, 1916 Race St., Philadelphia, PA 19103-1187, USA, 1995

COUNTRY OF PUBLICATION: USA

REPORT NO.: STP 1238

JOURNAL ANNOUNCEMENT: 9512

DOCUMENT TYPE: Conference Paper

LANGUAGE: ENGLISH

ABSTRACT: It has been generally agreed that the conventional salt spray test does not correlate nor simulate actual corrosion in service. Needs for a better test method instead of the salt spray test have risen also in Japan, and the various types of cyclic corrosion tests have been designed particularly in automotive and related companies. These tests are widely utilized because of better reproducibility and acceleration. To unify these test methods the Society of Automotive Engineers in Japan organized a technical committee. After five years of study JASO M 609 Standard for metallic and paint coatings on steel was published in 1991. Another standard for automotive parts was made in 1992. Both are basically the same cyclic corrosion test (CCT) which comprises 2 h of salt spray, followed by 4 h of dry and 2 h of wet condition per cycle. They have been also applied to other industrial fields. Some modified CCT combined with artificial light exposure have also been developed (for Al and steel). Graphs. 6 ref.

DESCRIPTORS: Conference Paper; Steels-- Corrosion; Aluminum-- Corrosion; Japan; Corrosion tests; Atmospheric corrosion; Protective coatings

SECTION HEADINGS: R6 (Corrosion/Electrochemistry/Chemical Reactions)

103.

786629 199512-R6-0406

What is accelerated in accelerated testing: a framework for definition.

Roberge, P R

CORPORATE SOURCE: Royal Military College (Canada)
CONFERENCE: Cyclic Cabinet Corrosion Testing, Dallas, TX, USA, 14-19 Nov. 1993 18-30 ISSN: 0-8031-2014-1
PUBL. DATE: 1995
PUBL: ASTM, 1916 Race St., Philadelphia, PA 19103-1187, USA, 1995
COUNTRY OF PUBLICATION: USA
REPORT NO.: STP 1238
JOURNAL ANNOUNCEMENT: 9512
DOCUMENT TYPE: Conference Paper
LANGUAGE: ENGLISH
ABSTRACT: Each failure or corrosion case is as specific as a human thumbprint or genetic make-up. There is often enough information generated by a failure analysis investigation to permit one to pinpoint the cause of failure to the role played by a few atoms located in a microscopic environment. The design and practice of accelerated corrosion testing for the purpose of ranking materials and processes would benefit greatly if the degradation modes caused by the tests being performed were better characterized and monitored. This paper reviews the acceleration factors commonly used in continuous and cyclic cabinet testing and discusses some of their impact on the results generated. The inadequacies of traditional salt spray testing is discussed in the light of a comprehensive framework of parameters leading to corrosion degradation. The importance in recognizing the presence of competing failure modes is examined in relation to the statistical characteristics of the underlying acceleration factors. (Discussed are Al alloys). 27 ref.
DESCRIPTORS: Conference Paper; Aluminum base alloys-- Corrosion; Accelerated tests; Salt spray tests; Corrosion environments
SECTION HEADINGS: R6 (Corrosion/Electrochemistry/Chemical Reactions)

104.

777614 199410-R6-0329
The Corrosion Behaviour of Zinc, Aluminium and Zinc--Aluminium Sprayed Layers in the Accelerated Corrosion Test.
Schulz, W -D
CORPORATE SOURCE: Institute for Protection Against Corrosion (Dresden)
JOURNAL: Schweissen Schneiden, 12/92, E218-E220 ISSN: 0036-7184
PUBL. DATE: Dec. 1992
Germany, 1992
COUNTRY OF PUBLICATION: Germany
JOURNAL ANNOUNCEMENT: 9410
DOCUMENT TYPE: Article
LANGUAGE: ENGLISH ; GERMAN
ABSTRACT: Investigations on the corrosion behaviour of zinc, aluminium and zinc--aluminium sprayed layers are described. The corrosion mechanisms of the various coating materials are explained by means of metallographic specimens, measurements of adhesive strength and standardized corrosion test methods. It is shown that in particular the remote protective action of the Zn influences the corrosion resistance of metal sprayed layers. Zn-55Al and Zn-15Al are mentioned.
DESCRIPTORS: Journal Article; Zinc base alloys-- Coatings; Aluminum base alloys-- Coatings; Zinc-- Coatings; Aluminum-- Coatings; Steels-- Coating; Corrosion resistance; Hot dip galvanizing
ALLOY INDEX(IDENTIFIER): Zn-55Al-- AL
SECTION HEADINGS: R6 (Corrosion/Electrochemistry/Chemical Reactions)

105.

771978 199401-R7-0091

Comparison of Cross-Sectional Image Analysis With Weight Change Measurements for Assessing Non-Uniform Attack During Corrosion Testing of Aluminium.

Peng, A Y M ; Lyon, S B ; Thompson, G E ; Johnson, J B ; Wood, G C ; Ferguson, J M

CORPORATE SOURCE: Industrial Technology Research Institute (Taiwan)

JOURNAL: British Corrosion Journal, 28, (2), 103-106 ISSN: 0007-0599

PUBL. DATE: 1993

COUNTRY OF PUBLICATION: UK

JOURNAL ANNOUNCEMENT: 9401

DOCUMENT TYPE: Article

LANGUAGE: ENGLISH

ABSTRACT: Samples of aluminium have been exposed in a cyclic wet--dry exposure test using a mixed salt spray. Conventional assessment of corrosion of the Al, by the weight changes after corrosion product stripping, implied a loss in metal cross-section of 28% after 22 weeks' testing. This result was compared with observation of cross-sectional losses using photographs of randomly selected cross-sections combined with quantitative image analysis. Results indicated that, in a significant number of locations, the loss of cross-sectional area was > 20% after 8 weeks and, after 22 weeks, the maximum loss in area was > 50% compared with an average loss of 30%. Such behaviour is not surprising because of the localised nature of Al corrosion. Thus, weight loss measurements, which are often used for corrosion rate assessment after accelerated salt spray testing, are clearly not appropriate in the case of non-uniform corrosion. However, image analysis using modern low cost equipment is a useful tool for the objective assessment of corrosion loss and may, depending upon the lifetime criterion in use, result in a useful reduction in overall testing time. Graphs. 10 ref.

DESCRIPTORS: Journal Article; Aluminum-- Corrosion; Wire-- Corrosion; Salt spray tests; Weight loss measurement; Image analysis; Corrosion rate; Criteria

SECTION HEADINGS: R7 (Testing/Analysis/Measurement/Metallography)

106.

767943 199308-R7-0375

New Accelerated Corrosion Test Methods.

Koch, U ; Hack, T

CORPORATE SOURCE: Deutsche Aerospace

JOURNAL: Gov. Res. Announc. Index, Pp 6 ISSN: 0097-9007

PUBL. DATE: 1991

COUNTRY OF PUBLICATION: USA

REPORT NO.: TIB/B92-03932/XAB

JOURNAL ANNOUNCEMENT: 9308

DOCUMENT TYPE: Report

LANGUAGE: ENGLISH

ABSTRACT: New accelerated corrosion test methods for conventional Al and new AlLi alloys and surface protection schemes were investigated. The aim is to improve the corrosion performance of modern European aircraft. The test equipment for the electrochemical monitoring techniques has been installed. One monitoring system will be used to monitor specimens during

stress corrosion tests. The other system will be applied during conventional accelerated corrosion tests and after long-term exposure. The installation of the monitoring equipment and sensors in a maritime reconnaissance aircraft is completed. The unit is located inside the aircraft and is connected by internal wiring to the sensors in the wing. In the field of MIC, samples from corroded sites of aircraft have been investigated. A variety of microorganisms could have been isolated.

DESCRIPTORS: Report; Aluminum base alloys-- Corrosion; Aircraft-- Corrosion; Stress corrosion tests; Accelerated tests; Monitoring; Electrochemistry; Al Li alloys

SECTION HEADINGS: R7 (Testing/Analysis/Measurement/Metallography)

107.

757374 199206-R7-0235

Time-Lapse Video Techniques in the Corrosion Testing of Aluminum Alloys.

Newton, C J ; Holroyd, N J H

CORPORATE SOURCE: Alcan International

CONFERENCE: New Methods for Corrosion Testing of Aluminum Alloys, San Francisco, California, USA, 21-22 May 1990 153-179

PUBL: ASTM, 1916 Race St., Philadelphia, Pennsylvania 19103, USA, 1992

COUNTRY OF PUBLICATION: USA

REPORT NO.: STP 1134

JOURNAL ANNOUNCEMENT: 9206

DOCUMENT TYPE: Conference Paper

LANGUAGE: ENGLISH

ABSTRACT: Described is the use of time-lapse video techniques for in situ observation during controlled and free corrosion of high-strength Al--Zn--Mg--Cu alloys 7075 and 7150 and two Al--Zn binary alloys. Direct observation of corroding 7075 in various tempers shows that, as a precursor to stable pit formation, a deformable gelatinous layer of corrosion product develops. Gas is evolved at the metal/hydrated oxide interface, which distorts the gel layer at potentials below those expected for pitting. During stress corrosion cracking of 7150 T6, time-lapse video images confirm that initial drying after total immersion of 0.6M NaCl solution leads to an acceleration in the apparent rate of crack growth from 5 x 10 exp --7 to 9 x 10 exp --6 m/s. This rate is sustained for only a few min but could help explain the aggressive nature of alternate immersion testing. Photomicrographs; Graphs. 29 ref.

DESCRIPTORS: Conference Paper; Aluminum base alloys-- Corrosion; Sodium chloride-- Environment; Stress corrosion cracking; Pitting (corrosion); Corrosion tests; Corrosion products-- Crystal growth; Video; Al Zn Mg Cu alloys; Al Zn alloys

ALLOY INDEX(IDENTIFIER): 7075, 7150, Al-0.48Zn, Al-4.3Zn-- AL

SECTION HEADINGS: R7 (Testing/Analysis/Measurement/Metallography)

108.

757371 199206-R7-0232

Materials Evaluation Using Wet--Dry Mixed Salt-Spray Tests.

Lyon, S B ; Thompson, G E ; Johnson, J B

CORPORATE SOURCE: UMIST

CONFERENCE: New Methods for Corrosion Testing of Aluminum Alloys, San Francisco, California, USA, 21-22 May 1990 20-31

PUBL: ASTM, 1916 Race St., Philadelphia, Pennsylvania 19103, USA, 1992

COUNTRY OF PUBLICATION: USA
REPORT NO.: STP 1134
JOURNAL ANNOUNCEMENT: 9206
DOCUMENT TYPE: Conference Paper
LANGUAGE: ENGLISH

ABSTRACT: Accelerated methods for corrosion testing of materials, based on the use of salt sprays, have been standardized since the early 1930s. However, despite the many significant advances in the mechanistic understanding of atmospheric corrosion phenomena since those days, most changes in accelerated test standards have been implemented to reduce the time of the tests, and thus their costs, by increasing their severity. Thus, although laboratory accelerated test methods have played an important role in the assessment of materials' performance, in general they have not been applied by virtue of their ability to simulate and enhance natural weathering. In particular, wet--dry cycles simulate the natural wetting and drying which occurs in practice and, under many conditions, can aid in the formation of naturally occurring corrosion product films, which frequently play a role in the kinetics of metal corrosion. In addition, the use of a relatively dilute mixed salt spray, in comparison with the more commonly used solutions based on 5% NaCl (e.g. ASTM B 117, Method for Salt-Spray Fog Testing) can result in corrosion morphologies and behavior which are more representative of natural conditions. Described is a wet--dry mixed salt-spray test using solutions containing mixtures of (NH4)2SO4 and NaCl with a 1 h wet/1 h dry cycle. The basis and reasons for using the test are discussed in depth, with the emphasis on illustrating the improvements in realism which are attained using this procedure rather than a standard continuous NaCl test. In addition, the results from accelerated corrosion testing of Al (99.5%, Al--Mg--Si) are presented to illustrate the main features of the test. Finally, possible developments and improvements in the salt-spray methods, including the use of solutions resembling artificial rainwater, are discussed. Graphs. 25 ref.

DESCRIPTORS: Conference Paper; Aluminum base alloys-- Corrosion; Salt spray tests; Atmospheric corrosion; Corrosion products-- Phases (state of matter); Accelerated tests; Pitting (corrosion); Commercial purity aluminum ; Al Mg Si alloys
SECTION HEADINGS: R7 (Testing/Analysis/Measurement/Metallography)

109.

756030 199204-R7-0144
Choosing an Accelerated Corrosion Test.
Altmayer, F
CORPORATE SOURCE: Scientific Control Laboratories
JOURNAL: Metal Finishing, 89, (1A), (Guidebook Directory), 570, 572-576
ISSN: 0026-0576
PUBL. DATE: Mid-Jan. 1991
COUNTRY OF PUBLICATION: USA
JOURNAL ANNOUNCEMENT: 9204
DOCUMENT TYPE: Article
LANGUAGE: ENGLISH

ABSTRACT: Guidelines which were prepared to assist in choosing the best accelerated corrosion test for a given application are presented. It is stressed that the accelerated test should simulate "real life" corrosion mechanisms as much as possible. The mechanisms of the two basic forms of corrosion which metallic products are subjected to during their service

life--electrochemical (galvanic) and chemical--are described. Each of the commonly performed accelerated corrosion and porosity tests is described in detail. A table which summarizes the applicability of the various tests and denotes the most common test used on a given coating/substrate combination is included for reference. Corrosion tests described are the: salt spray, 100% humidity, acetic acid--salt spray, Cu salt spray (CASS), corrodKote, fact, weatherometer, lactic acid, sulfur dioxide (Kesternich), triple spot, and electrographic and chemical tests for porosity. Coatings whose thickness is to be determined and which are included in the summary are anodic, black chrome, Cu and Cu alloys, electroless Ni, galvanize, hard chrome, phosphate coatings, paint, Sn plate, Sn--Ni plate, and Zn plate. Substrate materials are Al, steels, and several nonferrous alloys and nonconductors (printed circuit boards).

DESCRIPTORS: Journal Article; Aluminum-- Coating; Steels-- Coating; Nonferrous alloys-- Coating; Electronic devices-- Coating; Electroplates-- Corrosion; Accelerated tests

SECTION HEADINGS: R7 (Testing/Analysis/Measurement/Metallography)

110.

752337 91-640263

Choice of Testing, Evaluation Methods, and Quality Criteria in Corrosion Engineering.

Barton, K ; Knotkova, D ; Holler, P

CORPORATE SOURCE: G.V. Akimov State Research Institute for Materials Protection, ASTM

CONFERENCE: Corrosion Testing and Evaluation: Silver Anniversary Volume, Orlando, Florida, USA, 6-10 Nov. 1989 80-91

PUBL: ASTM, 1916 Race St., Philadelphia, Pennsylvania 19103, USA, 1990

REPORT NO.: STP 1000

JOURNAL ANNOUNCEMENT: 9110

DOCUMENT TYPE: CONFERENCE PAPER

LANGUAGE: ENGLISH

ABSTRACT: Proposed is a general scheme for the design of test programs to assess corrosion resistance in a meaningful way. Any metallic material (steel, Al, Cu, Zn) or coated metal product that is to be used in a specific set of conditions may suffer corrosion. The chemical and physical factors of the service application, together with the metallic material, determine the type and extent of corrosion damage encountered. Corrosion science can be used to specify the critical environmental factors in the test method. The test program can provide results that are important for the following: the development of new materials and coatings; the choice of protective systems for new equipment designs; the development of quality control programs and quality acceptance tests. Statistical methods are essential to determine the significance levels of results and the corresponding material specifications. 4 ref.--AA(US).

DESCRIPTORS: Corrosion tests-- Criteria; Accelerated tests-- Criteria; Corrosion resistance-- Evaluation

SECTION HEADINGS: 64 (Corrosion)

111.

739516 90-640056

Exfoliation Corrosion Testing of Al--Li Alloys 2090 and 2091.

Colvin, E L ; Murtha, S J

CORPORATE SOURCE: Alcoa Laboratories
CONFERENCE: Aluminum--Lithium Alloys. Vol. III, Williamsburg, Virginia, USA, 27-31 Mar. 1989 1251-1260
PUBL: Materials and Component Engineering Publications Ltd., P.O. Box 1550, Edgbaston, Birmingham B15 2JZ, UK, 1989
JOURNAL ANNOUNCEMENT: 9003
DOCUMENT TYPE: CONFERENCE PAPER
LANGUAGE: ENGLISH
ABSTRACT: Atmospheric exposure data show that Alloy 2090 in high strength tempers has excellent resistance to exfoliation corrosion. The exfoliation performance of Alloy 2091 in damage tolerant tempers can be highly variable, being especially dependent on grain structure. Results from the accelerated tests EXCO and MASTMAASIS are compared and recommendations are made concerning the applicability of each accelerated test for the two alloys. Photomicrographs. 10 ref.--AA(US).
DESCRIPTORS: US wrought alloy 2090-- Corrosion; Al Cu Li Zr wrought alloys-- Corrosion; US wrought alloy 2091-- Corrosion; Al Cu Li wrought alloys-- Corrosion; Exfoliation corrosion; Corrosion resistance; Corrosion tests; Corrosion environments
SECTION HEADINGS: 64 (Corrosion)

112.

723234 88-640069
Accelerated Atmospheric Corrosion Testing Using a Cyclic Wet/Dry Exposure Test: Aluminum, Galvanized Steel, and Steel.
Lyon, S B ; Thompson, G E ; Johnson, J B ; Wood, G C ; Ferguson, J M
CORPORATE SOURCE: UMIST, Central Electricity Research Laboratories
JOURNAL: Corrosion, 43, (12), 719-726 ISSN: 0010-9312
PUBL. DATE: Dec. 1987
JOURNAL ANNOUNCEMENT: 8803
DOCUMENT TYPE: ARTICLE
LANGUAGE: ENGLISH
ABSTRACT: Overhead electrical power transmission conductors, constructed from Al wires centrally reinforced by galvanized steel strands, have been found, in a few isolated instances, to suffer from internal corrosion, which is associated with the presence of chloride ion, and external corrosion, which is associated with sulfate ion. A cyclic wet/dry exposure test, with salt spray solutions containing appropriate ratios of sulfate and chloride ion, was used to simulate these observations. The parameters of the test are explained, and the performance of the exposed metals are reported in terms of weight loss and are compared with available data on the atmospheric corrosion of similar materials at industrial and marine locations. An acceleration of corrosion in the chamber of between 25-50 times was observed. The results are discussed in terms of the solution chemistry of the salt spray as it acts on the metal surface, with particular regard to the buffering capacity of ammonium and bicarbonate ion. The reality of the situation, with regard to atmospheric attack, is considered. It is clear that a true laboratory model should include a consideration of the chemistry on the surface in conjunction with dilution and concentration by surface-adsorbed moisture (wetting and drying) to represent the outside environment adequately. 23 ref.--AA(Alfed/UK/US).
DESCRIPTORS: Electric conductor Al alloys-- Atmospheric corrosion; Commercial purity aluminum-- Atmospheric corrosion; ACSR (conductors)-- Atmospheric corrosion; Transmission lines-- Atmospheric corrosion;

Corrosion rate-- Environmental effects; Galvanic corrosion-- Environmental effects; Accelerated tests-- Development
SECTION HEADINGS: 64 (Corrosion)

113.

715261 87-640049
A Review of Corrosion Failure Mechanisms During Accelerated Tests.
Steppan, J J ; Roth, J A ; Hall, L C ; Jeannotte, D A ; Carbone, S P
CORPORATE SOURCE: IBM
JOURNAL: J. Electrochem. Soc., 134, (1), 175-190 ISSN: 0013-4651
PUBL. DATE: Jan. 1987
JOURNAL ANNOUNCEMENT: 8703
DOCUMENT TYPE: ARTICLE
LANGUAGE: ENGLISH
ABSTRACT: An extensive literature review and assessment of corrosion failure mechanisms encountered during accelerated tests of microelectronic devices are presented. The failure mechanism of primary emphasis is electrolytic metal migration. The metallurgies of interest are Ag, Au, Cu, and Al. Electrochemical investigations of dendritic growth are also reviewed. Mechanistic results from the electrochemical investigations are discussed in light of the empirical results of accelerated tests. 152 ref.--AA(UK/US).
DESCRIPTORS: Electronic equipment components-- Corrosion; Galvanic corrosion-- Mechanisms; Corrosion mechanisms-- Evaluation
SECTION HEADINGS: 64 (Corrosion)

114.

713388 86-640324
Aspects of Accelerated SCC Tests on Aluminum Alloys in 3.5% NaCl Solution.
Shaw, W J D
CORPORATE SOURCE: American Society for Metals
CONFERENCE: Corrosion, Failure Analysis, and Metallography, Philadelphia, Pennsylvania, USA, 15-18 July 1984 565-581
PUBL: American Society for Metals, Metals Park, Ohio 44073, USA, 1986
JOURNAL ANNOUNCEMENT: 8612
DOCUMENT TYPE: CONFERENCE PAPER
LANGUAGE: ENGLISH
ABSTRACT: Using a constant rate of crack-opening displacement (COD), an evaluation of susceptibility to stress-corrosion cracking (SCC) in aerated 3.5% NaCl solution was made for four Al alloys (7075-T6, 2024-T4, 6061-T651, and IN 9021-T452). Based upon variations in KIC and KC between air and salt environment tests, the alloys can be grouped in order of sensitivity to this testing procedure as follows: 7075-T6, IN 9021-T452, 6061-T651, and 2024-T4. However, very little difference exists between the 6061 and 2024 alloys. The constant COD rate test is very similar to the constant strain rate test; however, the complexities of testing a precracked specimen yield surprisingly different results. These complexities are explained using the fracture morphology and microstructure of the material. 15 ref.--AA(US).
DESCRIPTORS: Al Cu Mg Mn wrought alloys-- Stress corrosion; Al Mg Si Cu wrought alloys-- Stress corrosion; Al Zn Mg Cu wrought alloys-- Stress corrosion; Al Cu Mg powder alloys-- Stress corrosion; Stress corrosion

resistance; Stress corrosion tests
SECTION HEADINGS: 64 (Corrosion)

115.

199034 84-640010
Accelerated Corrosion Testing. Final Report.
Khobaib, M
CORPORATE SOURCE: Systems Research Laboratories Inc
Pp 148
PUBL. DATE: Sept. 1982
REPORT NO.: N83-28211; AD-A125639; SRL-6507; AFWAL-TR-82-4186
JOURNAL ANNOUNCEMENT: 8401
DOCUMENT TYPE: REPORT
LANGUAGE: ENGLISH
ABSTRACT: Available methods for accelerated testing of corrosion behavior yield results which are not sufficiently accurate or reliable for predicting the service life of aircraft components and materials which degrade or fail due to environmental attack. Research has been conducted in controlled atmospheres on the localized environment enhancement of crack-growth rates of aerospace alloys to provide the basis for development of realistic accelerated corrosion tests. Slow-strain-rate, corrosion-fatigue and rising-load experiments have been conducted on high-strength 4340 steel and 7075-T6 Al alloy using accelerating pollutants such as sulfur dioxide, nitrogen dioxide, surface salt and ambient to 100% relative humidity (RH) air in a specially designed atmospheric chamber.--STAR.
DESCRIPTORS: US wrought alloy 7075-- Corrosion tests; Al Zn Mg Cu wrought alloys-- Corrosion tests; Accelerated tests; Aircraft components-- Corrosion; Corrosion environments; Corrosion fatigue
SECTION HEADINGS: 64 (Corrosion)

116.

190690 82-640284
Corrosion Test on Aluminum Alloys Adaptable for Automobiles. (Accelerated Test). (Pamphlet).
Nemoto, S ; Yamada, K
CORPORATE SOURCE: Mitsubishi Aluminium Co Ltd, Society of Automotive Engineers
CONFERENCE: International Congress and Exposition, Detroit, Mich., 22-26 Feb. 1982 (820286), Pp 29
PUBL: Society of Automotive Engineers, 400 Commonwealth Dr., Warrendale, Pa. 15096, 1982
JOURNAL ANNOUNCEMENT: 8210
DOCUMENT TYPE: CONFERENCE PAPER
LANGUAGE: ENGLISH
ABSTRACT: An accelerated corrosion test that was 5% salt spray test and alternate immersion test in 5% NaCl solution and 4.7% CaCl2 solution were used to examine the corrosion resistance of Al alloys for automobiles. Aluminum alloys used in these tests were 2036, 5182, 6061, 7016 and AC4C with several finishes. The results showed that Al alloys generated shallow pitting corrosion and steels generated a large amount of corrosion products. In the case of weld-bonded (spot-welded) specimens, there developed galvanic and crevice corrosion, especially galvanic corrosion

exhibited on the side of Al alloys. The results of the alternate immersion test in 5% NaCl solution were very similar to 5% salt spray test. The alternate immersion test in CaCl2 solution generated deeper pittings on Al specimens than in NaCl solution.--AA.

DESCRIPTORS: Automobiles-- Materials selection; Al wrought alloys-- Corrosion tests; Pitting (corrosion); Spot welds-- Corrosion mechanisms; Salt water-- Corrosion environments

SECTION HEADINGS: 64 (Corrosion)

117.

175145 80-640148

A Comparison of Various Stress-Corrosion Test Procedures Applied to Three Aluminum Alloy Plates.

Gray, J A

CORPORATE SOURCE: Royal Aircraft Establishment

Pp 41

PUBL. DATE: Sept. 1979

REPORT NO.: Tech. Rep. 79117

JOURNAL ANNOUNCEMENT: 8007

DOCUMENT TYPE: REPORT

LANGUAGE: ENGLISH

ABSTRACT: A 1974 assessment of plate alloys DTD 5020A (2014-T651), DTD 5050B (7075-T651) and DTD 5090 (2024-T351) is confirmed. Plate was 76 mm thick. DTD 5020A is the least susceptible, DTD 5090 the most. Results of alternate-immersion and marine-atmosphere tests using smooth testpieces showed agreement. Use of micro- rather than macrofailure criteria resulted in better agreement in threshold stress values. The Al--Cu (2000-series) alloys were far less susceptible in bend than in tensile tests, particularly when failure was judged on the appearance of surface cracks visible at 10x magnification (the macrofailure criterion). Use of the German LN 65666 test to determine alloy relative susceptibilities gives results different from those by alternate-immersion or nature marine-atmosphere tests. Further evaluation using inhibited Cl'-containing solutions, including the LN 65666 solution, is required.7 refs.--EPAA/AF.

DESCRIPTORS: US wrought alloy 2014-- Stress corrosion resistance; US wrought alloy 2024-- Stress corrosion resistance; US wrought alloy 7075-- Stress corrosion resistance; Al Cu Mg wrought alloys-- Stress corrosion resistance; Al Zn Mg Cu wrought alloys-- Stress corrosion resistance; Stress corrosion resistance-- Composition effects; Atmospheric corrosion tests; Accelerated tests

SECTION HEADINGS: 64 (Corrosion)

118.

164903 79-640069

Accelerated SCC Testing of AlZnMgCu Alloys--Test Methods, Ranking.

Lage, K ; Lars, J

CONFERENCE: Corrosion and Corrosion Protection of Aluminum, Budapest, Hungary, 8-12 Nov. 1976 203-214

PUBL: Omkdk-Technoinform, Budapest, 1976

JOURNAL ANNOUNCEMENT: 7902

DOCUMENT TYPE: CONFERENCE PAPER

LANGUAGE: ENGLISH

ABSTRACT: Tests on AlZnMg alloys showed that a 3% Na Cl + 0.5% aqueous

solution at <o<p<r<H 3 is suitable for accelerated SCC testing of alloys. The SCC process is strongly temperature dependent. An apparent activation energy of <as 45 kJ\mole at <o<p<r<H 3 has been found in the temp interval 20-80 <de<C. It is suggested that accelerated SCC testing of material with good SCC properties should be performed at an elevated temp. temp dependence means an acceleration of <as 20 times for a temp rise from + 20 <de<C to + 90 <de<C. The SCC resistance of the eight different alloys tested cannot be adequately expressed by a simple degree of alloying"' relationship. The SCC mechanism is considered to involve atomic embrittlement along grain boundaries. Probably the H<s<+<r reduction and H<i<2<r molecule formation properties of the surface oxides is of major importance.12 refs.--AA.

DESCRIPTORS: Al Zn Mg Cu wrought alloys-- Stress corrosion tests; Stress corrosion tests-- Temperature effects; Accelerated tests; Stress corrosion resistance

SECTION HEADINGS: 64 (Corrosion)

119.

1944643 MA Number: 199707-22-0575

Comparison of accelerated and atmospheric exposure tests for corrosion of aluminium alloys.

de Damborenea, J ; Conde, A

Centro Nacional de Investigaciones Metalurgicas (Spain)

British Corrosion Journal 30, (4), 292-296 1995 ISSN: 0007-0599

Journal Announcement: 9707

Document Type: Article

Language: ENGLISH

Abstract: Two Al-Cu alloys (2024-T4 and 7075-T7351) and two Al-Li alloys (2091-T84 and 8090-T8171) were exposed for two years in a moderately aggressive marine environment and their corrosion behaviour was compared with that in accelerated test for intergranular corrosion (AIR 9048 and MIL H-6088F) and exfoliation (ASTM G-34). Exfoliation tests using solutions modified by previous exposure to the test solution until a constant pH was obtained were also carried out with the two Al-Li alloys. Although the accelerated tests do produce the type of attack intended, the results in the aggressive exco solutions do not agree well with those from outdoor exposure, even using the modified solutions. Graphs; Photomicrographs. 10 ref.

Descriptors: Journal Article; Aluminum base alloys-- Corrosion; Accelerated tests; Atmospheric corrosion tests; Marine environments; Intergranular corrosion; Exfoliation corrosion

Alloy Index(Identifier): 2024-- AL/ 7075-- AL/ 2091-- AL/ 8090-- AL

Section Headings: 22 (TESTING AND CONTROL); 35 (CORROSION)

120.

02071453 A93-31501

New methods for corrosion testing of aluminum alloys

AGARWALA, VINOD S. (U.S. Navy, Naval Air Development Center, Warminster, PA); UGIANSKY, GILBERT M., EDS.

PLACE OF PUBLICATION: Philadelphia, PA PUBLISHER: American Society for Testing and Materials (ASTM Special Technical Publication, No. 1134) 1992

227P.

REPORT NO.: ASTM STP-1134; ISBN 0-8031-1435-4

LANGUAGE: English
COUNTRY OF ORIGIN: United States COUNTRY OF PUBLICATION: United States
DOCUMENT TYPE: COLLECTED WORK; CONFERENCE PROCEEDINGS
JOURNAL ANNOUNCEMENT: IAA9311

This symposium presents papers on a modification of the EXCO test method for exfoliation corrosion susceptibility in 7XXX, 2XXX, and aluminum-lithium alloys; materials evaluation using wet-dry mixed salt-spray tests; a comparison of potentiodynamic polarization tests with wet-dry mixed salt-spray testing of Al-Mg-Si alloy; an accelerated test for determining microbiological-influenced corrosion resistance of aluminum alloys; and corrosion of aluminum in Al alloys in nitric acid. Attention is also given to exfoliation corrosion testing of Al-Li alloys, damage-based assessment of stress corrosion performances among aluminum, and corrosion fatigue crack growth rate of Al-Li alloy sheet and its weldment. Other papers are on potentiometric and potentiostatic determination of the corrosion rate of welded 2519 aluminum alloy, time-lapse video techniques in the corrosion testing of aluminum alloys, and an examination of the influence of lithium on the repassivation rate of aluminum alloys. (For individual items see A93-31502 to A93-31514) (I.S.)

SOURCE OF ABSTRACT/SUBFILE: AIAA
DESCRIPTORS: *ALUMINUM ALLOYS; *CONFERENCES; *CORROSION TESTS; ACCELERATED LIFE TESTS; ALUMINUM-LITHIUM ALLOYS; CORROSION RESISTANCE; CRACK PROPAGATION; DAMAGE ASSESSMENT; METAL FATIGUE; SALT SPRAY TESTS; STRESS CORROSION CRACKING
SUBJECT CLASSIFICATION: 7526 Metallic Materials (1975-)

121.

02044529 N92-28794
Outdoor corrosion testing of aluminium-lithium alloys
SCHRA, L.; THART, W. G. J.; BOOGERS, J. A. M.
National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.
CORPORATE CODE: NE736790
Aug. 1990 62P.
REPORT NO.: NLR-TP-90272-U; ETN-92-91395
CONTRACT NO.: NIVR-01404-N
LANGUAGE: English
COUNTRY OF ORIGIN: Netherlands COUNTRY OF PUBLICATION: Netherlands
DOCUMENT TYPE: REPORT
DOCUMENTS AVAILABLE FROM AIAA Technical Library
OTHER AVAILABILITY: CASI HC A04/MF A01
JOURNAL ANNOUNCEMENT: STAR9219

The results of outdoor corrosion and stress corrosion tests, conducted on Al-Li plate and sheet materials for 3 and almost 5 years respectively, are summarized. The results of outdoor corrosion experiments are given. The peak aged XXXA-T651 (8090-T651) exhibited greater exfoliation corrosion resistance than 2047-T351 and 2324-T39 plate. The 2091-T3 and 2024-T3 sheet were found to be unsuspectable to exfoliation corrosion. The exfoliation susceptibility of 2091 increased with increased ageing. The 8090-T8 sheet showed blistering rather than exfoliation corrosion. The exfoliation attack of the plate material was generally much more severe than that of the sheet material. The MASTMAASIS test seems to be most promising for predicting the exfoliation corrosion resistance of Al-Li alloys in natural environments. There is a need for a simple and rapid immersion test, because the EXCO

test proved to be unreliable for characterizing the exfoliation susceptibility of Al-Li alloys. The results of the stress corrosion tests are given. The Stress Corrosion Cracking (SCC) initiation resistance of XXXA-T651 plate was similar to or slightly better than that of 2024-T351 and 2324-T39 plate. For SCC growth the ranking of materials depended on the influence of Corrosion Product Wedging (CPW) on SCC growth. When the influence was small, as in the first 1 1/2 years of testing, 2024-T351 and 2324-T39 exhibited slower crack growth; whereas XXXA-T651 was superior when there was a significant influence, as in the latter part of testing. Alternate immersion SCC initiation testing in synthetic seawater resulted in the same trends as outdoor exposure. SCC Growth in laboratory test environments was greatly influenced by CPW. (ESA)

DESCRIPTORS: *ACCELERATED LIFE TESTS; *ALUMINUM ALLOYS; *CORROSION TESTS; *LITHIUM ALLOYS; AGING (MATERIALS); CORROSION RESISTANCE; CRACK PROPAGATION ; SALT SPRAY TESTS; STRESS CORROSION CRACKING; STRESS INTENSITY FACTORS

SUBJECT CLASSIFICATION: 7526 Metallic Materials (1975-)

122.

00903509 N94-13532

The ASCOR test: A simple automated method for stress corrosion testing of aluminium alloys

SCHRA, L.; GROEP, F. F. (National Aerospace Lab., Emmeloord, Netherlands.)

National Aerospace Lab., Amsterdam (Netherlands). Materials Dept.

CORPORATE CODE: NE736790

Nov. 1991 22P.

PUBLICATION NOTE: Submitted for publication

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LANGUAGE: English

COUNTRY OF ORIGIN: Netherlands COUNTRY OF PUBLICATION: Netherlands

DOCUMENT TYPE: PREPRINT

DOCUMENTS AVAILABLE FROM AIAA Technical Library

OTHER AVAILABILITY: CASI HC A03/MF A01

JOURNAL ANNOUNCEMENT: STAR9402

A simple automated stress corrosion testing method called the ASCOR (Automated Stress COrrosion Ring) test was developed to test aluminum alloys according to the ASTM specification G44. The method involves testing cylindrical or sheet specimens in a loading ring provided with strain gauges to measure the load. Initiation of a stress corrosion crack results in a small load decrease. During the test, the load is measured periodically and stored in a data acquisition system controlled by a personal computer. A specific load decrease is used as the criterion for stress corrosion crack initiation. The main advantages of the method are that a large number of specimens can be tested simultaneously in a climate chamber, and that stress corrosion cracking initiation lives can be determined according to a clearly defined criterion without time consuming and subjective inspections, and without disturbing the test procedure. (ESA)

DESCRIPTORS: *ALUMINUM ALLOYS; *CRACKING (FRACTURING); *STRAIN GAGES; *STRESS CORROSION; ACCELERATED LIFE TESTS; CRACK INITIATION; DATA ACQUISITION; SALT BATHS; TENSILE STRESS

SUBJECT CLASSIFICATION: 7526 Metallic Materials (1975-)

123.

00548800 A72-30541

An accelerated laboratory stress corrosion test for Al-Zn-Mg alloys. (Anodic salt-chromate stress corrosion resistance test of Al-Zn-Mg alloys, noting time reduction and correlation with natural environment exposures)

JEFFREY, P. W.; WRIGHT, T. E.; GODARD, H. P. (Alcan Research and Development, Ltd., Kingston, Ontario, Canada)

In: International Congress on Metallic Corrosion, 4th, Amsterdam, Netherlands, September 7-14, 1969, Proceedings. (A72-30534 14-17) Houston, Tex., National Association of Corrosion Engineers, 1972, p. 133-138; Discussion, p. 138, 139.

1972 7 REFS.

LANGUAGE: English

COUNTRY OF ORIGIN: Canada COUNTRY OF PUBLICATION: United States

DOCUMENT TYPE: CONFERENCE PAPER

JOURNAL ANNOUNCEMENT: IAA7214

The Anodic Salt-Chromate test described was developed with the idea in mind that any practical stress corrosion test must be simple, reasonably rapid, and capable of consistent duplication. The test should also cause a minimum of general surface corrosion so as to prevent any confusion as to the mode of failure. An electrolyte composed of 2.0% NaCl and 0.5% sodium chromate is employed at room temperature for the test. A current density of 0.3 mA/sq in. offered the best compromise between a short test life and freedom from undue surface corrosion in the case of tests with Al-Zn-Mg specimens. (G.R.)

SOURCE OF ABSTRACT/SUBFILE: AIAA

DESCRIPTORS: *ALUMINUM ALLOYS; *CORROSION RESISTANCE; *CORROSION TESTS; *STRESS CORROSION; CHROMATES; CONFERENCES; CURRENT DENSITY; FAILURE MODES; MAGNESIUM ALLOYS; ROOM TEMPERATURE; ZINC ALLOYS

SUBJECT CLASSIFICATION: 6517 Materials, Metallic (1965-74)

124.

10509997 PASCAL No.: 93-0019248

Comparison of accelerated SCC tests performed on the aluminium alloy 2014-T651

Vergleich verschiedener beschleunigter Pruefverfahren fuer das Spannungsrisskorrosionsverhalten am Beispiel der Legierung 2014-T651

(Comparaison des essais acceleres de fissuration en corrosion sous contraintes realises sur l'alliage d'aluminium 2014-T651)

BRAUN R

Inst. Werkstoff-Forschung, Deutsche Forschungsanstalt Luft- Raumfahrt, 5000 Koeln, Federal Republic of Germany

Journal: Werkstoffe und Korrosion, 1992, 43 (9) 453-458

ISSN: 0043-2822 CODEN: WSKRAT Availability: INIST-526; 354000030711320060

No. of Refs.: 7 ref.

Document Type: P (Serial) ; A (Analytic)

Country of Publication: Federal Republic of Germany

Language: English Summary Language: German

The stress corrosion cracking (SCC) behaviour of plates of the Al-Cu-Si-Mn-Mg alloy 2014-T651 was investigated in short transverse direction performing various accelerated tests. Corrosive media used were: aqueous 3.5% NaCl solution, an aqueous solution of 2% NaCl+0.5% Na SUB 2 CrO SUB 4 at pH = 3 (according to LN 65666), and substitute ocean water according to ASTM D1141. C-ring and tensile specimens were loaded under

constant deformation, constant load and slow strain rate conditions. Alternate immersion tests in 3.5% NaCl solution clearly indicate the low SCC resistance of the alloy 2014-T651 in short transverse direction

English Descriptors: Aluminium alloy; Corrosion test; Stress corrosion cracking; Sodium Chromates; Sodium chloride; Aqueous solution; Seawater; Comparative study; Test method; Immersion test; Aluminium Copper Magnesium Manganese Silicon Alloys; Slow strain rate test

125.

778224 199411-R6-0389
Results of Long Term Corrosion Tests in Marine Environments.
Huppatz, W ; Dahmen, H ; Wieser, D
CORPORATE SOURCE: Vereinigte Aluminium Werke
CONFERENCE: Third International Conference on Aluminium Alloys: Their Physical and Mechanical Properties. Vol. 2, Trondheim, Norway, 22-26 June 1992 429-434
PUBL: Sintef Metallurgy, Trondheim, N-7034, Norway, 1992
COUNTRY OF PUBLICATION: Norway
JOURNAL ANNOUNCEMENT: 9411
DOCUMENT TYPE: Conference Paper
LANGUAGE: ENGLISH
ABSTRACT: Alloys 6060, 6082, 6061, 7020 and AlZn5Mg1.7 in different conditions were exposed for up to ten years on Helgoland. Specimens of these alloys were mounted on the testing equipment which allowed constant tidal immersion and exposure in the splash zone. Welded extrusions were tested to find out the corrosion behaviour of the weldment joint and the heat affected zone. For single samples of each alloy the corrosion potential in seawater was measured and related to the threshold potentials of pitting which were determined by potentiostatic polarization measurements in the laboratory. Graphs. 3 ref.
DESCRIPTORS: Conference Paper; Aluminum base alloys-- Corrosion; Welded joints-- Corrosion; Corrosion potential; Pitting (corrosion); Marine environments; Al Mg Si Fe alloys; Al Si Mg Mn alloys; Al Mg Si Cu alloys; Al Zn Mg alloys
ALLOY INDEX(IDENTIFIER): 6060-- AL/6082-- AL/6061-- AL/7020-- AL/ AlZn5Mg1.7-- AL
SECTION HEADINGS: R6 (Corrosion/Electrochemistry/Chemical Reactions)

126.

770709 199311-R7-0543
ASCOR Test: a Simple Automated Method for Stress Corrosion Testing of Aluminium Alloys.
Schra, L ; Groep, F F
CORPORATE SOURCE: National Aerospace Laboratory (Netherlands)
JOURNAL: Gov. Res. Announc. Index, Pp 23 ISSN: 0097-9007
PUBL. DATE: 1991
COUNTRY OF PUBLICATION: USA
REPORT NO.: PB93-211597/XAB
JOURNAL ANNOUNCEMENT: 9311
DOCUMENT TYPE: Report
LANGUAGE: ENGLISH
ABSTRACT: Alternate immersion stress corrosion testing according to ASTM

specification G44 has proven to be representative for aluminium alloys in natural environments resembling the actual environmental conditions for aircraft. A simple automated stress corrosion testing method called the ASCOR (automated stress corrosion ring) test was developed to test Al alloys according to the specification. The method involves testing cyclindrical or sheet specimens in a loading ring provided with strain gauges to measure the load. Initiation of a stress corrosion crack results in a small load decrease. During the test the load is measured periodically and stored in a data acquisition system controlled by a personal computer.

DESCRIPTORS: Report; Aluminum base alloys-- Corrosion; Aircraft components-- Corrosion; Stress corrosion cracking; Corrosion tests; Computer control; Specifications

SECTION HEADINGS: R7 (Testing/Analysis/Measurement/Metallography)

127.

728453 88-640242

Stress Corrosion Testing of Al--Zn--Mg Alloys.

Sahu, M D

CORPORATE SOURCE: Research and Development Establishment (India)

CONFERENCE: 10th International Congress on Metallic Corrosion. Vol. 3: Sessions 10-13, Madras, India, 7-11 Nov. 1987 JOURNAL: Key Eng. Mater., 20-28, (3), 2051-2061 ISSN: 0252-1059

PUBL. DATE: 1988

JOURNAL ANNOUNCEMENT: 8811

DOCUMENT TYPE: CONFERENCE PAPER

LANGUAGE: ENGLISH

ABSTRACT: A stress corrosion test procedure that makes use of electrochemical potentiostatic polarization techniques has been described. A potentiostatic stress corrosion life curve can be developed for various materials at different stress levels. The best material and optimum stressing condition can be determined for best stress corrosion resistance. Samples (e.g. Al--Zr--Mg alloys) withstanding 5000 h exposure, under time to failure test, are considered to have good stress corrosion resistance. 8 ref.--AA(US).

DESCRIPTORS: Al Zn Mg wrought alloys-- Stress corrosion; Extrusions-- Stress corrosion; Welded joints-- Stress corrosion; Bridges (military)-- Stress corrosion; Stress corrosion cracking-- Environmental effects

SECTION HEADINGS: 64 (Corrosion)

128.

1567945 MA Number: 88-350739

Electrochemical Monitoring of Aluminium Corrosion in a Cyclic Atmospheric Test Chamber.

Shirkhanzadeh, M ; Thompson, G E ; Lyon, S B ; Johnson, J B

UMIST

Br. Corros. J. 22, (4), 243-249 1987 ISSN: 0007-0599

Journal Announcement: 8804

Document Type: ARTICLE

Language: ENGLISH

Abstract: A three electrode probe, comprising an Al electrode of interest with surrounding graphite half rings, has been employed to study the corrosion behaviour of Al in an atmospheric test chamber, using a mixed salt spray with wet/dry cycling. The potential response of the probe

reveals four distinct regions associated with initial wetting, the presence of a continuous electrolyte film and initial and final drying. Understanding of the potential response, in terms of the corrosion behaviour of Al, is assisted by the use of intermittent polarization, whereby Al is transiently connected to one graphite electrode. Thus, localized corrosion initiates in the misting periods with enhanced corrosion in the early stages of electrolyte solution concentration through drying. Development of corrosion products in the concentrating electrolyte solution probably hinders further corrosion at such sites. On the other hand, with increased times of exposure in the cabinet, the general development of corrosion products assists in the trapping of electrolyte solution, keeping the surface wet, with continued corrosion activity. Quantification of the corrosion rate of Al over the period of exposure is not possible, largely due to localized corrosion beneath the electrolyte droplets in the presence of a discontinuous electrolyte solution film. However, the probe sensitively monitors the various regions prevailing in the atmospheric test chamber. 28 ref.--AA

Descriptors: Aluminum-- Corrosion; Atmospheric corrosion tests; Salt spray tests; Corrosion potential

Section Headings: 35 (CORROSION)

129.

863705 MA Number: 83-352177

The Use of Micro-Electrodes in the Study of Localised Corrosion in Aluminium Alloys.

Tuck, C D S

Conference: Electrochemical Techniques in Corrosion Testing and Research, Manchester, England, 4-6 Jan. 1982

Corros. Sci. 23, (4), 379-389 1983 ISSN: 0010-938X

Journal Announcement: 8310

Document Type: ARTICLE

Language: ENGLISH

Abstract: Micro-electrodes of three types: silver/silver chloride, tin/tin oxide and calomel, were constructed and evaluated on their usefulness in identifying local anodic and cathodic sites on aluminium weld specimens and an aluminum alloy surface as they were scanned mechanically over a polished surface. The solution environment in which the specimens were placed was shown to have a critical effect on the detectability of local electrode sites and a solution of low conductivity was shown to be essential if the electrodes were microscopic in size. The modified calomel electrode which was able to be used in dry conditions showed the most usefulness in detecting electrode potential differences during a scan although its coarseness was found to be disadvantageous. 16 ref.--AA

Descriptors: Aluminum base alloys-- Corrosion; Electrodes; Corrosion potential; Welded joints-- Corrosion

Alloy Index(Identifier): 7017, Al-5Mg, 6063-- AL

Section Headings: 35 (CORROSION)

130.

554367 MA Number: 77-350137

Galvanostatic Vs. Potentiostatic Control in Corrosion Fatigue Testing of Al Alloys.

McGuinness, J L ; Devereux, O F

Metall Trans A Oct. 1976, 7A, (10), 1587-1589.
Journal Announcement: 7702
Document Type: ARTICLE
Language: ENGLISH
Descriptors: Aluminum base alloys-- Corrosion; Corrosion tests; Fatigue tests; Electrochemistry; Sodium chloride-- Environment
Alloy Index(Identifier): 7075-- AL
Section Headings: 35 (CORROSION)

131.

01155290 E.I. Monthly No: EI8210085143 E.I. Yearly No: EI82003587
Title: JOMINY END-QUENCH TEST FOR INVESTIGATION OF CORROSION PROPERTIES AND MICROSTRUCTURE OF HIGH STRENGTH ALUMINIUM ALLOYS.
Author: 't Hart, W. G. J.; Kolkman, H. J.; Schra, L.
Corporate Source: Natl Aerosp Lab, Amsterdam, Neth
Source: Natl Lucht Ruimtevaartlab Versl Verh NLR TR 80102 U Nov 1980 47 p
Publication Year: 1980
CODEN: VVNLA2
Language: ENGLISH
Journal Announcement: 8210
Abstract: The Jominy end-quench test was applied to extruded rods of the aluminum alloys 2024 and 7075 to obtain a decreasing quench rate over the length of the rods. Subsequently the alloys were heat treated to the conditions: 2024-T4, 2024-T6, 7075-T6 and 7075-T73. A corrosion investigation and a transmission electron microscopy investigation were performed to examine the relation between quench rate, corrosion properties and microstructure. 19 refs.
Descriptors: *AIRCRAFT MATERIALS--*Conversion; ALUMINUM AND ALLOYS--Corrosion Protection
Classification Codes:
415 (Metals, Wood & Other Structural Materials); 652 (Aircraft); 652 (Aircraft); 541 (Aluminum & Alloys)
41 (CONSTRUCTION MATERIALS); 65 (AEROSPACE ENGINEERING); 63 (FLUID DYNAMICS & VACUUM TECHNOLOGY); 54 (METAL GROUPS)

132.

01309768 INSPEC Abstract Number: A79020296
Title: Evaluation of the constant rate test method for testing stress corrosion cracking in aluminium alloys
Author(s): de Jong, H.F.
Author Affiliation: Delft Univ. of Technol., Dept. of Aerospace Engng., Delft, Netherlands
Journal: Corrosion vol.34, no.1 p.32-6
Publication Date: Jan. 1978 Country of Publication: USA
CODEN: CORRAK ISSN: 0010-9312
Language: English Document Type: Journal Paper (JP)
Treatment: Experimental (X)
Abstract: A general description is given of the use of the constant strain rate method for testing stress corrosion cracking (SCC). A comparison is made between the test results obtained with the constant strain rate method and those obtained with the constant load method and the constant total strain method. These results were obtained in tests on an aluminum 7075 T651 alloy at various pH values and chloride ion

concentrations. It is shown that there is a good agreement between the results obtained with these three test methods. (11 Refs)

Descriptors: aluminium alloys; corrosion testing; stress corrosion cracking

Identifiers: constant rate test method; stress corrosion cracking; pH values; chloride ion concentrations; Al alloy 7075 T651

Class Codes: A6220M (Fatigue, brittleness, fracture, and cracks); A8160B (Metals and alloys); A8170 (Materials testing)